The Special Education Eyecare (SEE) Project: Exploring the impact of in-school vision care for children in special education

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I confirm that the word count of this thesis is less than 100,000 words.

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Summary

Background

Children with special educational needs (SpEN) are more likely to have a serious vision problem compared to their typically developing peers. Studies have identified the difficulties that this group of children have in accessing regular eyecare. It has also been reported that the visual limitations of children with SpEN are not being effectively communicated to key stakeholders involved in their care and education.

Aims

The overall aim was to determine whether implementation of a comprehensive in-school eyecare service model, designed by professional bodies and charities in the UK, results in measurable benefits in terms of visual status and how well visual needs are recognised and addressed by parents and education providers.

A secondary aim was to determine the current in-school eyecare provision available to children attending special schools in Northern Ireland.

Methods

A four phase quasi-experimental mixed methods design was adopted. The first phase examined the extent of in-school vision services available to children attending 36 special schools in Northern Ireland. The second phase tested the feasibility of research protocol, recruitment strategies and instruments used for data collection. The third experimental phase assessed visual function and determined parental and teacher knowledge of visual limitations for 200 children at baseline. Measures were re-evaluated 2-5 months after the comprehensive in-school eyecare model had been implemented. The fourth phase examined the Statements of Educational Need (SEN) for information and support on how to manage visual limitations in an educational setting for children who were identified as having a visual deficit at baseline. SEN were reviewed 12 months later to determine if there had been any amendments following recommendations included in written reports issued to parents and teachers at baseline.

Results

Inequalities were identified in the in-school vision services available to special schools in Northern Ireland. The extent to which eye health and visual status are investigated and outcomes communicated to stakeholders also varied vastly between and within Health and Social Care Trusts.

Overall unmet visual need significantly reduced and visual status improved following the implementation of the comprehensive in-school eyecare model. However, a third of unmet need remained and was predominantly attributed to non-compliance of spectacle wear. In addition, all SEN remained unchanged despite recommendations for the inclusion of strategies to account for visual limitations.

Conclusions

This study has, for the first time, demonstrated measurable visual benefits to children in special education settings when they receive comprehensive in-school eyecare. However, further directions for policy and research are suggested for implementing the in-school eyecare framework at an organisational level.

Abbreviations

AHP	**Allied Health Professional**
ASD	Autism Spectrum Disorder
EHCP	Education Health and Care Plan
GP	General Practitioner
MLD	Moderate learning difficulty
MLD/SLD	Moderate to severe learning difficulty
Near-PVA	Near presenting visual acuity
NI	Northern Ireland
PECS	Picture Exchange System
PVA	Presenting visual acuity
QTVI	Qualified Teacher of Visual Impairment
SEN	Statement of Educational Need
SLD	Severe learning difficulty
SpEN	Special Educational Needs
UK	United Kingdom

Access to contents

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Chapter 1- Literature review

This chapter reviews the most relevant literature pertaining to the visual problems associated with children with special educational needs and the current eyecare provision available to them.

1.1. Introduction

"Special educational needs" is a universal term to describe the additional provision required from educators to account for a learning difficulty that may prevent or impede a child accessing educational facilities. For example, a teacher may use Picture Exchange Communication Systems (PECS) to communicate information to a child with Autism Spectrum Disorder (ASD), as with ASD learning is easier when done visually (Bondy & Frost, 1994).

Special educational needs is a broad term which encapsulates an array of conditions. In Northern Ireland these conditions have been classified into five overarching categories which are detailed in Table 1.

Overarching Special Educational needs category	**Specific categories**		
Cognition and learning	Profound and Multiple Learning Difficulties (PMLD)		
	Severe Learning Difficulties (SLD)		
	Moderate Learning Difficulties (MLD)		
	Dyscalculia		
	Dyslexia		
Social, Behavioural, Emotional and Well-being	Social and Behavioural Difficulties		
	Emotional and Well-being Difficulties		
	Severe Challenging Behaviour associated with SLD or PMLD		
Speech, Language and Communication Needs	Developmental Language Disorder		
	Language Disorder associated with a differentiating biomedical condition		
	Communication and Social Interaction Difficulties		
Sensory	Blind		
	Partially sighted		
	Severe/Profound Hearing Impairment		
	Mild/Moderate Hearing impairment		
	Multi-sensory impairment		
Physical Needs/ Medical diagnosis	Down syndrome	Cerebral palsy	Autism Spectrum Disorder
	Epilepsy	Diabetes	Asthma
	Anaphylaxis	Attention Deficit Disorder	Global developmental delay
	Complex healthcare needs	Anxiety disorder	Depression
	Eating disorder	Psychosis	Other mental disorder
	Spina Bifida with hydrocephalus	Spina Bifida without hydrocephalus	Muscular dystrophy
	Acquired brain injury	Physical disability	Other Medical condition/syndrome

Table 1. *Special Educational Needs overarching and specific categories updated categories* (Education Authority Northern Ireland, 2019)

Across the world, children with special educational needs are issued with a document that outlines short-term and long-term education goals and details the necessary services and resources required from schools and healthcare professionals to meet these goals (Mitchell *et al.,* 2010). In the UK this document is known as a "Statement of Educational

Need" (SEN) and more recently in England, an "Education Health and Care Plan" (EHCP). The document is created by the Education Authority following assessment of the child by a multi-disciplinary team which typically includes an educational psychologist, a social worker, a paediatrician, a speech and language therapist, an occupational therapist and a physiotherapist. Additional input is requested from other professionals where deemed necessary by either the parent or the education authority (Stroggilos *et al.,* 2006; NI Government services(a); Mitchell *et al.,* 2010; Andreasson *et al.,* 2013).

Northern Ireland has the highest percentage of the school population educated in special schools (1.6%) compared with the rest of the United Kingdom (England 1.3%, Scotland 1.0% and Wales 1.0%) (The Department of Education, 2018; Department of Education, 2018; Scottish Government, 2018; Welsh Government, 2018). Therefore, Northern Ireland is an ideal demographic for collecting data on this particular population.

1.1.1. Terminology used to describe children attending special education schools in the literature

Publications examining visual function have used differing terminologies to describe participants attending special education schools, these include:

- Mentally handicapped (Gardiner, 1967; Bankes, 1974)
- Mentally retarded (Lawson *et al.,* 1971; Woodruff, 1977)
- Developmentally handicapped (Edwards *et al*., 1972)
- Mentally defective (Markovits, 1975)
- Developmentally delayed (Welinder *et al.*, 2012; Nielsen *et al.,* 2007b)
- Cognitively impaired (Tsao *et al.,* 2017)
- Children with a disability (Kaur *et al.,* 2016)
- Children with learning disabilities (Gogate *et al.,* 2011)

- Children with special needs (Das *et al.,* 2010; Woodhouse *et al.,* 2014; Ezeh *et al.,* 2018; Puri *et al.,* 2015; Bodack, 2011; Donaldson *et al*., 2019; Pilling *et al.,* 2017)

The UK government published guidelines on the correct language to use when discussing disability (Office for Disability Issues, 2018). The guidelines recommend avoiding the terms "mentally handicapped", "mentally defective" and "mentally retarded" and instead replacing them with "learning disability/disabilities".

Although learning disability accounts for the majority (36.1-57.9%) of primary needs for children attending special schools in the UK (Department of Education, 2017; Department of Education (Northern Ireland), 2017) there are also those who do not have a learning disability (Table 1.). Henceforth, children attending special schools will be referred to as children with "special educational needs" (SpEN).

1.1.2. Inequality in healthcare

It has been repeatedly shown in the literature that children and adults with disabilities experience lower rates of preventive care than the general population (Merrick *et al.,* 2004; Prokup *et al.,* 2019; Lewis *et al.,* 2016; Janicki *et al.,* 2002; Krahn *et al.,*2006; NHS England, 2017; Taggart & Cousins, 2014). Two of the main barriers encountered when people with disabilities try to access healthcare services are reported by the World Health Organisation (WHO) to be:

i. No transport to medical facilities
ii. Inadequate healthcare equipment (World Health Organization, 2011)

The UK government has identified the need for better access to healthcare for children with disabilities with improved cooperation and sharing of information between healthcare and educational services (NHS England, 2019; Children and Families Act, 2014; Children and Young People (Scotland) Act, 2014; Special Educational Needs and Disability Act (Northern Ireland), 2016; Additional Learning Needs and Education Tribunal (Wales) Act, 2018). The importance of delivering care in the most appropriate setting with minimal disruption to education, has also been identified as an important component of paediatric health services (Department of Health, 2016; Department of Health, 2010).

This chapter aims to review the current literature for information on the **visual function** of children with SpEN, the **eyecare provision** available to them and the mechanisms used to **communicate visual problems** detected in this population to educators and those involved in their care.

1.2. Visual function of children with special education needs (SpEN)

In 1967 P.A. Gardiner performed eye examinations on 60 children with SpEN in London on the request of the school doctors due to the difficulties in assessing the visual acuity and ocular health in this group of children. Gardiner reported that teaching staff were unaware of the impact the visual defects detected in the children were having on behaviour and educability. In 1972 Edwards *et al.* performed eye examinations on 728 children with SpEN in Louisville, United States. Edwards established that in 16% of participants, visual function was a contributing factor to their social adjustment and education problems. Bankes *et al*. (1974) and Woodruff *et al.* (1977) recommended that ophthalmic examinations should be part of the routine assessment of children with SpEN due to the high prevalence of ocular defects.

Although there is an abundance of publications describing the visual function of specific populations e.g. Down syndrome, cerebral palsy and Autism Spectrum Disorder (ASD), there is limited data investigating special school populations as a group.

The prevalence of visual problems from the available data are described below.

1.2.1. Refractive error

Refractive error is an eye condition in which images from the outside world fail to focus on the retina. Types of refractive error include myopia, hyperopia and astigmatism. Myopic eyes have difficulty seeing distant objects whereas hyperopic eyes struggle to focus on near objects. Astigmatic eyes are irregular in shape leading to distorted vision at distance and near.

Nine publications were identified from a literature search which described the refractive status of children attending special education schools; five from Europe (Donaldson *et al.,* 2019; Pilling *et al.,* 2017; Woodhouse *et al.,* 2014; Das *et al.,* 2010; Nielsen *et al.,* 2007b) and four from South East Asia (Tsao *et al.,* 2017; Kaur *et al.,* 2016; Puri *et al.,* 2015; Gogate *et al*., 2011). The definition of refractive error varied. Table 1.1. details the findings from each study.

	Definition (SER)	**Cyclopentolate used?**	**Prevalence**	**Corresponding literature**	**Demographic**	**Total N**
Hyperopia	≥+1.00D	No	8.4%	*Tsao et al., 2016*	Taiwan	241
		Yes	6.7%	*Kaur et al., 2016*	India	404
		Yes	14.0%	*Puri et al., 2015*	Nepal	150
	≥+2.00D	Yes- in 5% of cases	15.2%	*Donaldson et al., 2019*	London	949
		Yes	17%	*Pilling et al., 2017*	Bradford	157
		Yes-in 9.2% of cases	14.5%	*Woodhouse et al., 2013*	Wales	173
		Yes	22.8%	*Das et al., 2010*	Glasgow	228
	≥+3.00D	No	3.4%	*Tsao et al., 2016*	Taiwan	241

		Yes in 40% of cases	10.6%	*Gogate et al., 2011*	India	526
		Yes	15.3%	*Nielsen et al., 2007*	Denmark	923
Myopia	≤-0.50D	Yes- in 5% of cases	22.3%	*Donaldson et al., 2019*	London	949
		Yes	15%	*Pilling et al., 2017*	Bradford	157
		Yes	13.1%	*Kaur et al., 2016*	India	404
		Yes-in 9.2% of cases	13.9%	*Woodhouse et al., 2014*	Wales	173
		Yes	9.6%	*Das et al., 2010*	Glasgow	225
		Yes	10.8%	*Nielsen et al., 2007*	Denmark	923
	<-0.50D	Yes	16.0%	*Puri et al., 2015*	Nepal	150
	≤-1.00D	No	27.0%	*Tsao et al., 2016*	Taiwan	241
		Yes in 40% of cases	10.5%	*Gogate et al., 2011*	India	526
	≤-3.00D	No	11.3%	*Tsao et al., 2016*	Taiwan	241
Astigmatism	≤-0.50DC	No	65%	*Tsao et al., 2016*	Taiwan	241
		Yes	3.2%	*Kaur et al., 2016*	India	404
		Yes in 40% of cases	5.7%	*Gogate et al., 2011*	India	526
	≤-0.75DC	Yes	17%	*Pilling et al., 2017*	Bradford	157
		Yes-in 9.2% of cases	18.5%	*Woodhouse et al., 2014*	Wales	173
		Yes	32%	*Das et al., 2010*	Glasgow	225
	<-1.00DC	Yes	20.6%	*Nielsen et al., 2007*	Denmark	923
	≤-1.00DC	Yes- in 5% of cases	28.6%	*Donaldson et al., 2019*	London	949
		Yes	20.7%	*Puri et al., 2015*	Nepal	150
	≤2.00DC	No	14.9%	*Tsao et al., 2016*	Taiwan	241

Table 1.1. *Reported refractive error in children attending special schools.*

Cycloplegic refraction involves the instillation of eye drops and is recognised as the gold-standard technique to determine refractive error to avoid over/under-estimation of measurements (Morgan *et al.,* 2015). Five of the studies identified employed cycloplegic refraction, three studies used cyclopentolate on between 5% and 40% of participants and one study did not use cycloplegia on any participants.

Hashemi *et al.* (2018) performed a systematic review and meta-analysis of refractive errors in typically developing children and adults across the world according to the WHO regions. Studies were considered eligible for inclusion if cycloplegic refraction was used for determining refractive error. The results from the meta-analysis for typically developing children in Europe and South East Asia are compared with the refractive error of children attending special education schools in the same region. N.B. Only studies that employed cycloplegic refraction on all participants are included (Tables 1.2. and 1.3.).

	Europe	
Refractive error	**Children with SpEN** (*Nielsen et al., 2007; Das et al., 2010; Pilling et al., 2017)*	**Typically developing children** *(Hashemi et al., 2018)*
Hyperopia (≥+2.00D)	17 to 22.8%	9.0%
Myopia (≤-0.50D)	9.6 to 15%	14.3%
Astigmatism (≤-0.75DC)	17 to 32%	
Astigmatism (<-0.50DC)		12.9%
Astigmatism (<-1.00DC)	20.6%	

Table 1.2. *Prevalence of refractive error in children attending special education schools compared to typically developing children in Europe*

	South-East Asia	
Refractive error	**Children with SpEN** *(Kaur et al., 2016; Puri et al., 2015)*	**Typically developing children** *(Hashemi et. al 2018)*
Hyperopia (≥+1.00D)	6.7 to 14.0%	
Hyperopia (≥+2.00D)		2.2%
Myopia (<-0.50D)	16.0%	4.9%
Astigmatism (<-0.50DC)	3.2%	9.8%

Table 1.3. *Prevalence of refractive error in children attending special education schools compared to typically developing children in South-East Asia*

European children attending special schools had a higher prevalence of hyperopia and astigmatism compared to typically developing children however a similar percentage of myopia was found. Conversely a lower percentage of astigmatism and a higher percentage of myopia was present in children attending special schools compared to typically developing children in South East Asia.

1.2.2. Accommodative function

Accommodation is the ability of the eye's internal lens to adjust its power and magnification to enable focus on near objects. If a person has poor accommodative function, i.e. a 'lag of accommodation', they will find close up objects blurred and will struggle with tasks such as reading and writing.

Table 1.4. displays the reported accommodative function of children with SpEN and typically developing children using dynamic retinoscopy technique (Donaldson *et al.,* 2019; Woodhouse *et al.,* 2014; Anketell *et al.,* 2018).

Study (n)	Demographic	Population	% of participants with a lag of accommodation
Donaldson et al., 2019 (n= 949)	London	SpEN	10.6
Woodhouse et al., 2014 (n=173)	Wales	SpEN	14.3
Anketell et al., 2018 (n=202)	Northern Ireland	Typically developing children	4.9

Table 1.4. *Accommodative lag reported in children with special educational needs and in typically developing children.*

The prevalence of accommodative lag was reported to be between two to three times higher in children with SpEN compared to typically developing children.

1.2.3. Visual acuity deficit

Visual acuity describes the ability of the eye to resolve high contrast detail. The level of visual acuity will determine the clarity of vision. Children with significantly poor visual acuity will struggle with everyday tasks such as reading or crossing the road. Table 1.5. illustrates the reported prevalence of distance visual acuity deficits within a SpEN population. Three studies were omitted from the table for the following reasons:

- Defective acuity was not defined (Gogri *et al.,* 2016)
- The measurement unit of acuity could not be determined, i.e. unknown to be either Snellen, logMAR or decimal (Tsao *et al.,* 2017)
- Only children with an acuity level poorer than 0.1logMAR were detailed (Kaur *et al.,* 2016)

	% of participants with defined level of distance visual acuity deficit				
Study	**>*1.0logMAR**	**>0.5logMAR**	**≥0.5logMAR**	**>0.3logMAR**	**≥0.3logMAR**
Donaldson et al., 2019			24.9%		
Ezeh et al., 2018	3.8%	12.5%			
Piling et al., 2017		29%			
Puri et al., 2015	3%	25%		72%	
Woodhouse et al., 2014				13.9%	
Welinder et al., 2012			11%		
Gogate et al., 2011	10.1%	29%			
Das et al., 2010		12.1%			
Nielsen et al., 2007	3.8%		10.5%		17.8%
Gardiner et al., 1967					28.3%

Table 1.5. *Distance visual acuity deficit in children with SpEN. *in terms of visual acuity >means poorer than.*

Pascolini *et al.* (2010) performed a systematic review of global visual impairment and estimated that 1.0% of 0 to 14-year olds in the world have a visual impairment (acuity >0.5logMAR). This differs greatly from the 12.1-29% found within the SpEN population.

1.2.4. Manifest strabismus

A manifest strabismus or squint is the term used to describe misalignment of the visual axes of a pair of eyes. This can lead to symptoms of double vision in cases of sudden onset strabismus or, if the deviation is long-standing, the eye which is turning away from the visual axis can become amblyopic (lazy).

The prevalence of strabismus in a population of children with SpEN has been reported to be between 14.0 to 40% (Gardiner, 1967; Nielsen *et al.,* 2007; Das *et al.,* 2010; Bodack, 2011; Gogate *et al*., 2011; Woodhouse *et al.,* 2014; Puri *et al.,* 2015; Kaur *et al.,* 2016; Gogri *et al.,* 2016; Tsao *et al.,* 2017; Donaldson *et al.,* 2019; Edwards *et al.,* 1972; Bankes, 1974; Woodruff, 1977). This compares to 0.8 to 5% reported in typically developing children (Williams *et al.,* 2008; Chia *et al.,* 2010; Fu *et al*., 2014).

The prevalence of strabismus is significantly higher in children with SpEN than in typically developing children.

1.2.5. Nystagmus

Nystagmus is a condition in which the eyes 'wobble'; this involuntary eye movement reduces the visual acuity achieved by the eye, both for distant and close-up objects (Barot *et al.,* 2013). Nystagmus is usually a congenital condition and its prevalence in children with SpEN is reported to range from 2.4-16.6% (Das *et al.,* 2010; Woodhouse *et al.,* 2014; Donaldson *et al.,* 2019; Gogate *et al.,* 2011; Kaur *et al.,* 2016; Gogri *et al.,* 2016; Tsao *et al.,* 2017) whereas in the general population the prevalence is estimated to be 0.24% (Sarvananthan *et al.,* 2009).

1.2.6. Ocular deficits

Table 1.6. illustrates the ocular deficits previously identified in children with SpEN. The Welsh study (Woodhouse *et al.,* 2014) recorded the highest prevalence of eyelid

abnormalities, corneal defects and lens abnormalities compared to the other studies. This may be due to the employment of a hand-held biomicroscope (slit lamp) to examine external ocular health, in contrast to other studies which did not use this instrumentation.

Ocular deficit	%	Corresponding literature
Eyelid abnormalities	1 to 26.6	*Edwards et al., 1972; Woodhouse et al., 2014; Puri et al., 2015; Donaldson et al., 2019*
Corneal defects	0.3 to 11.8	*Edwards et al., 1972; Das et al., 2010; Woodhouse et al., 2014; Puri et al., 2015; Donaldson et al., 2019*
Lens abnormalities	1.2 to 7.5	*Edwards et al., 1972; Das et al., 2010; Woodhouse et al., 2014; Puri et al., 2015; Tsao et al., 2017; Donaldson et al., 2019*
Optic disc abnormalities	1.2 to 15.1	*Edwards et al., 1972; Das et al., 2010; Woodhouse et al., 2014; Puri et al., 2015; Tsao et al., 2017; Donaldson et al., 2019*
Retinal issues	0.4 to 3	*Edwards et al., 1972; Das et al., 2010; Puri et al., 2015; Tsao et al., 2017; Donaldson et al., 2019*

Table 1.6. *Ocular deficits in children with neuro-disabilities/ attending special schools*

1.2.7. Visual field defects

Visual field describes the extent of a person's peripheral vision. The normal visual field extends 90 degrees temporally to central fixation, 50 degrees superiorly and nasally and 60 degrees inferiorly (Spector, 1990). Peripheral vision is important for a child's mobility as defects can lead to bumping into objects, falling or tripping. Four studies examined the visual field of participants (Nielsen *et al.,* 2007; Welinder *et al.,* 2012; Gogri *et al.,* 2016; Donaldson *et al.,* 2019) and reported a range in prevalence from 1.4% to 4.1%; including hemianopia, general constriction and inferior defects.

1.2.8. Contrast sensitivity

Contrast sensitivity describes the ability to recognise a spatial pattern not only by its size, but also to by its contrast. Amblyopia resulting from strabismus or uncorrected anisometropia has been shown to inhibit binocular contrast sensitivity (Pardhan & Gilchrist, 1992). Compared to visual acuity, the contrast sensitivity function correlates better with performance in visually guided everyday activities such as walking, eating, reading and the ability to recognise faces (Owsley, 2003).

Nielsen *et al.* (2011) and Gogri *et al.* (2016) reported the prevalence of reduced contrast sensitivity to be 11.7% and 25.2% respectively in children with SpEN.

1.3. Risk factors associated with visual problems in children with special educational needs (SpEN).

ASD, Down syndrome and cerebral palsy account for almost a quarter of the special school population in the UK (Department of Education, 2017; Department of Education (Northern Ireland), 2017). Visual problems associated with these conditions have been widely reported in the literature and are summarised in the below.

1.3.1. Down syndrome

Down syndrome is a genetic condition caused by the presence of all or part of chromosome 21, it typically causes some level of learning disability and characteristic physical features.

Ocular conditions associated with Down syndrome (DS) have been widely documented including; blepharitis, epiphoria, lid abnormalities, keratoconus, Brushfield spots, cataract, retinal anomalies, optic nerve anomalies and glaucoma (Creavin & Brown, 2009). A literature review by

Watt *et al.* (2015) showed that the most common ocular disorders affecting children with DS were amblyopia 17% (Ljubic *et al.,* 2011), strabismus 42% (Haugen *et al.,* 2001) hyperopia 57% (John *et al.,* 2004), astigmatism (increases with age) 22%-37.5% (Woodhouse *et al.,* 1997) and reduced accommodation (Woodhouse *et al.,* 1996; Woodhouse *et al.,* 1993; Cregg *et al.,* 2001). Reduced contrast sensitivity (Courage *et al.,* 1997) and visual acuity (Woodhouse *et al.,* 1996, Courage *et al.,* 1994) are also reported to be associated with Down syndrome.

1.3.2. Cerebral palsy

Cerebral palsy is a group of neurological conditions that affect muscle movement and co-ordination. Philip e*t al.* (2014) carried out a review identifying and characterising cerebral impairment in children. They reported that visual difficulties are multiple in children with cerebral palsy and are seen in 60-75% of cases (Scgenek-Rootlieb *et al.,* 1994). Reduced accommodation has been found in 50% of children in a population-based study of children with cerebral palsy (McClelland *et al*., 2006).

Frequency and severity of visual conditions relate to the severity of the movement disorder (Ghasia *et al.,* 2008). Fazzi *et al.* (2012) categorised children with cerebral palsy into three categories, those with diplegia, hemiplegia and quadriplegia. They found that in the children with diplegia, 82% were found to have lower visual acuity than expected for their age, 75% had clinically significant refractive error and 90% strabismus. The children with hemiplegia exhibited similar percentages of clinically significant refractive error and strabismus but they had the largest proportion of visual field impairment (64%). Children with quadriplegia were most affected by reduced visual acuity (98%), optic atrophy (98%) and disorders of eye movement (100%). McClelland *et al.* (2006) reported that reduced accommodative responses were significantly associated with children with cerebral palsy who had more severe motor impairments.

1.3.3. Autism Spectrum Disorder (ASD)

ASD is a developmental disability that affects how the individual interacts socially, their communication, interests and behaviour. Table 1.7. summarises a list of visual sensory symptoms in ASD reported by (Bogdashina, 2016)

Hyper	**Hypo**
Focusing on tiny pieces of dust/particles	Attracted to light
Dislike of dark and bright light	Looking intensely at objects or people
Dislike of sharp flashes of light	Moving fingers or objects in front of eyes
Looking down most of the time	Fascination with reflections and/or brightly coloured objects
Covering/closing eyes at bright lights	Running hands around the edges of objects

Table 1.7. *Visual sensory symptoms in ASD* (Bogdashina, 2016).

A higher prevalence of refractive error, strabismus and accommodative lag is reported in children with ASD compared with typically developing children (Simmons *et al.,* 2009; Scharre *et al.,* 1992; Anketell *et al*., 2013; Anketell *et al*., 2018).

1.4. Eyecare for children with special educational needs (SpEN).

1.4.1. Access to eyecare

It is clear from the literature that children with SpEN have a higher risk of visual problems however Prokup *et al.* (2019) reported that this group of children are almost three times more likely to have unmet vision needs compared to their typically developing peers. The authors suggest that one of the barriers to meeting visual needs of these children is challenges in accessing eyecare.

A review of the literature identifies that the number of children in special education with a history of eyecare varies across countries, ranging from 6.8 to 71% (Table 1.8.).

Study	Demographic	% of participants with no previous history of eyecare
Nielsen et al., 2007	Denmark	29%
Woodhouse et al., 2014	Wales	42.2%
Piling et al., 2017	England	37.6%
Ezeh et al., 2018	Nigeria	93.2%
Donaldson et al., 2019	England	44%

Table 1.8. *Parental report of previous eyecare of children within a special educational needs population.*

Children in the Nigerian study had the lowest percentage of previous eye care at 6.8%. In Nigeria parents are required to pay for their child's eyecare unlike in Denmark and the UK. This was one of the contributing factors that parents reported for not having a previous eye check along with, "parents did not feel the need for an eye check" and the belief that "my type of child cannot be examined by the eye doctor" (Ezeh *et al.,* 2018) . Danish children with SpEN reported the highest percentage of eyecare (Nielsen *et al.,* 2007a). However, over 95% of children in Denmark are estimated to receive vision testing as part of a physician health assessment at age three to four years old

(Forebyggelsesråd, 2010). Despite this provision in Denmark 29% of children with special educational needs still failed to receive any visual assessment.

In the UK Public Health England recommends that vision screening is offered to all 4-5 years old in primary one (Public Health England, 2019). The screening test comprises a monocular measure of visual acuity using a crowded logMAR letter test. A "pass" constitutes a visual acuity of 0.2logMAR or better in each eye. If acuity is poorer than this level, it is recorded as a "fail" and the child is referred for further investigation. However, a report by Hall and Elliman advises all children with neurological disabilities should be offered a full eye examination in replacement of screening due to the increased risk of visual problems (Hall & Elliman, 2006).

In Wales over 40% of children with SpEN were reported to have no previous history of no eyecare (Woodhouse *et al.,* 2014) . Parents in a small sample survey (n=15) described the difficulty they had taking their child to a clinic for an eye examination. One described the clinical experience as causing "panic attacks and too much stress" for their child and another stated that for the last ten years they have been unable to find an eyecare professional to test their child (Woodhouse *et al.,* 2014).

Similarly, 44% of children attending special schools in London had no previous history of eyecare (Donaldson *et al.,* 2019) . In Glasgow, Das *et al.* (2010) found that 18% of the children examined had a significant prescription but no history of glasses. In Bradford, local NHS policy dictates that children identified as having developmental delay should be referred automatically from paediatric services to the hospital eye service as part of their general workup. However, Pilling *et al.* (2017) found that 62% of children attending special primary schools in Bradford were unknown to the hospital eye service.

In Northern Ireland a recent audit of vision screening in special schools involved the collection of data from a universal surveillance system (which records information on health checks) to identify whether children born between 02/07/2008 and 01/07/2009 had received in-school vision screening. Although a high percentage of in-school screening was recorded in this sample of 232 children attending special schools in Northern Ireland, the level of eyecare offered was not equitable. 62.1% had vision screening performed by a school nurse whereas 24.1% had 'enhanced' vision screening performed by an orthoptist; neither of these types of vision screening include assessment of refractive error which is known to occur at higher rates in children with SpEN and which has a significant impact on visual function and outcomes. 5.1% of children had been given a vision screening by an "other" professional and 0.5% by an unknown professional. It is not clear who these professionals were, or what their assessment entailed.

1.4.2. Communication of visual problems

Lehman (2013) acknowledges that there is a need for effective communication of vision results and any recommended strategies to account for visual deficits to parents and those involved in the child's care and education. Lehman suggests that a report should include a measure of visual acuity, including information regarding any specific diagnosis, and recommendations tailored to any problems the child is encountering. These recommendations should make reference to environment, characteristics of visual material, daily living activities, methods of communication and mobility and should be included in the child's SEN/ECHP. Mitchell & Sloper (2002) also recommend that information should be up-to-date, accurate and presented in plain and simple terms.

Unidentified visual issues can act as a further barrier to learning for children who already encounter learning difficulties. It is therefore important that this information is shared in an appropriate and meaningful way to parents and those involved in the child's health and education.

Woodhouse *et al.* (2014) and Donaldson *et al.* (2019) communicated findings from in-school eye examinations to parents and teachers through a written report. Donaldson *et al.* (2019) included recommendations for environmental modifications at home and/or school to account for visual deficits. Gogri *et al.* (2015) verbally suggested environmental adjustments to teachers to meet each child's visual needs. Parents of children examined as part of an in-school optometric service in New York (Bodack, 2011) were advised the results of the test through a written report. Occupational therapists who accompanied the child to the eye examination, explained findings to teachers and worked with the optometrist in implementing recommended treatments.

The value of reporting visual outcomes and the impact on visual needs is yet to be investigated.

Little and Saunders (2015) reviewed the SEN/ECHPs of children attending a special school in Northern Ireland. Fifty-five percent of participants had either reduced visual acuity or a significant refractive error which was not recorded on their SEN/ECHP.

Currently, there are no published data investigating the impact of reporting of visual deficits and classroom modifications on how well visual support needs are articulated in SEN/ECHP.

1.5. Bridging the gaps

Key eyecare stakeholders and charities in the UK recognise the challenges in accessing eyecare for both children with SpEN and their families. As a means to promote equitable access to regular eyecare they have collaboratively designed a framework for in-school eyecare for special educational settings (The Royal College of Ophthalmologists, 2016) and the Clinical Council for Eye Health Commissioning has given its endorsement for a comprehensive and targeted programme of eyecare for children and young people in special schools in England. The in-school eyecare model aims to ensure children with SpEN have access to eyecare, including comprehensive eye examinations and dispensing of spectacles, in a familiar setting; and that parents, teachers and other stakeholders receive meaningful information to support children's visual needs at home and school.

1.5.1. Study aims

The present study aims, for the first time, to determine whether implementation of the aforementioned comprehensive in-school eyecare model results in measurable benefits in terms of visual status and how well visual needs are recognised and addressed by parents and education providers.

1.5.2. Study objectives

i) Determine the extent of the in-school vision services currently available to children attending special schools in Northern Ireland.
ii) Explore the feasibility of research protocol, recruitment strategies and instruments used for data collection within a SpEN population.
iii) Determine whether implementation of a comprehensive in-school eyecare model and the reporting of outcomes results in measurable benefits for children in terms of their visual status and how well any significant visual deficits are recognised, or compensated for, in the school environment.
iv) Determine whether SEN were amended to include strategies recommended in written reports to minimise visual limitations detected as part of the in-school eyecare model

Additional investigations of visual processing and classroom behaviour were undertaken before and after implementation of the in-school eyecare model as part of a broader project in a parallel study. Findings are not presented in this thesis but are reported by Black et al. (2019).

Chapter 2: In-school vision services in special education settings in Northern Ireland: A survey of current provision.

This chapter describes the vision services currently being delivered within special schools in Northern Ireland.

2.1. Introduction

2.1.1. In-school vision assessment for the special school population

The National Screening Committee recommends that all children aged between 4 and 5 years old in the United Kingdom should be offered in-school vision screening (National Screening Committee 2013). The recommended screening test comprises a monocular measure of visual acuity using a crowded logMAR letter test. A "pass" constitutes a visual acuity of 0.2logMAR or better in each eye. If acuity is poorer than this level, it is recorded as a "fail" and the child is referred for further investigation. The precise diagnostic pathway for failures in school vision screening varies across the UK; in Northern Ireland all 'fails' are referred directly to a hospital eye clinic. The principal aim of the screening is to detect children with amblyopia, but screening may also pick up the common predisposing conditions of amblyopia i.e. strabismus and refractive error (Public Health England 2017).

As demonstrated in Chapter 1, it is widely reported in the literature that children with SpEN are more likely to have visual problems and ophthalmic disorders compared to typically developing children. This group of children have also been shown to have difficulty in completing a logMAR letter test which is the visual acuity test recommended by the National Screening Committee. Donaldson *et al.* (2019) reported only 6.4% (10/156) of children aged 4 to 5 years old with complex needs attending a special education setting were able to complete the Keeler logMAR crowded test. A low success rate was also reported by Anketell *et al.* (2018) who retrospectively examined the records of 232 children with SpEN and found that a crowded logMAR letter acuity test was only possible in 37.5% of children.

McCullough & Saunders (2019) demonstrated that 7.8% of children who ‘passed’ the UK school visual screening protocol had a significant visual deficit that was not detected, i.e. refractive error/strabismus.

These publications support the “Health for All Children” report (Hall & Elliman, 2006) which clearly states that vison screening isn’t appropriate for children with developmental disability. Therefore ‘case finding’ through comprehensive eye examinations instead of visual screening has been proposed as a more appropriate approach by key stakeholders and charities in the UK (The Royal College of Ophthalmologists, 2016) .

2.1.2. Northern Ireland’s health and education services

The Children and Families Act (2014) and the Children’s Services Co-Operation Act (Northern Ireland) (2015) state that there should be integration, cooperation and the sharing of resources between education services and health and social care to promote the quality of provision of services for children with SpEN. Northern Ireland’s healthcare and education services are managed by two separate authorities. Healthcare is provided by five regional Trusts: Belfast, Northern, South Eastern, Southern and Western Trusts (Figure 2). Historically, education services were provided by five similar regional education and library boards: Belfast, North Eastern, South Eastern, Southern and Western Boards. However, in 2015 these departments were combined to create the Education Authority as a result of the Education Act Northern Ireland (2014).

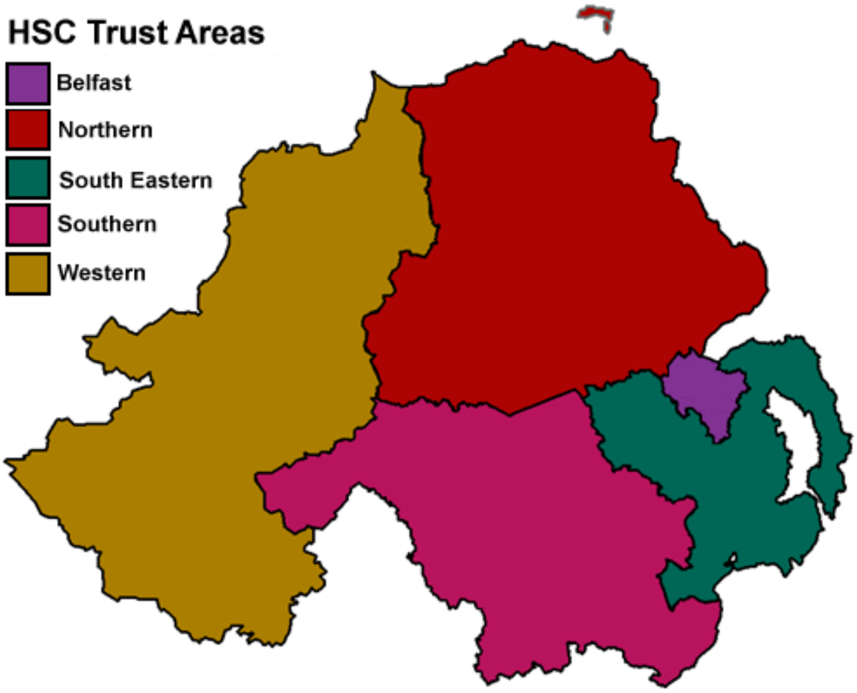


Figure 2. *Health and Social Care Trusts in Northern Ireland (Health and Social Care Northern Ireland)*

Although education services are now delivered by a single authority, in-school health provision available to children attending special schools, such as occupational therapy services, is still determined by individual Health and Social Care Trusts.

2.1.3. In-school eyecare services available to children attending special education schools in Northern Ireland.

Communication with parents, professionals and personal experience indicated that eyecare services for children with special needs are not consistent across Northern Ireland.

Following queries from special schools and the Northern Ireland Assembly, in 2014 the Public Health Agency initiated a three-phase review of the support Allied Health Professionals (AHPs) provide to children with Statements of Educational Need (Public Health Agency, 2015a). The AHPs featured in the review are physiotherapy, occupational therapy, speech and language therapy, dietetics, orthoptics and podiatry. The review aimed to:

- Establish current levels and models of AHP provision for children with statements of educational need in both special schools (Phase 1) and in mainstream schools (Phase 2).
- Make recommendations based on the themes identified in Phases 1 and 2.
- Produce a regional framework and implementation plan (Phase 3).

Phase 1 and 2 have been completed and recommendations were publicised in 2016 however, disappointingly, the regional framework produced in phase 3 has not been published as it is yet to be approved by Northern Ireland's Health Minister.

Questionnaires and direct contact with parents/carers and children alongside meetings with professional stakeholders were used as information gathering tools for the reviewers to establish the level of AHP support available to children with statements of educational need. Feedback from questionnaires highlight inequality across all AHP services offered, the need for better communication of medical conditions to parents and educators and the importance of a multidisciplinary approach (Public Health Agency 2015b, 2016).

Although this review has potential to inform understanding of vision services in special education settings through the input of orthoptic AHPs, it extends across a large group of professions resulting in the outputs being broad and generalised. Furthermore, as no regional framework and implementation plan has been published it is difficult to determine what would be an appropriate approach to standardise or improve services.

In 2018, an audit of vision screening in special education schools in Northern Ireland was published by the Regulation and Quality Improvement Authority (Anketell *et al*., 2018). The audit acknowledged a disparity in the screening offered in special schools in Northern

Ireland i.e. 67% of the sample receiving vision screening by a School Nurse vs. 26% receiving a more detailed ‘enhanced visual screening’ (but not a full eye examination) by an Orthoptist. The demographics of the disparities were not detailed in the audit, nor was the role of optometrists or indeed the role of orthoptists.

2.1.4. Aims

The current study aims to bridge the gap in the literature by establishing the extent of vision services currently available to children attending each special school in Northern Ireland.

2.1.5. Objectives

i) Determine which schools have vision services available to pupils in-school.
ii) Determine the extent to which eye health and visual status are investigated and outcomes communicated to stakeholders.
iii) Examine any disparities identifies between the in-school vision services across the five Health and Social Care Trusts.

2.2. Methods

2.2.1. Ethics

Approval for the study was obtained from Ulster University’s Research Ethics Committee. The research adhered to the principles behind the Declaration of Helsinki. Ethical implications are detailed in Appendix 1.

2.2.2. Survey Design

The survey design was based on the SeeAbility questionnaire conducted in England (SeeAbility, 2014) and a similar survey delivered to special schools in Wales (Woodhouse *et al.*, 2012). There was a low response rate (13.6%) from the English special schools and feedback indicated a higher response rate may have been achieved if the survey was shorter and in an online format. The current survey was redesigned taking these recommendations into account.

To meet the aim of this study in establishing the current vision services available to children attending special schools in Northern Ireland, the survey was condensed to 12 key multiple-choice questions:

1. What is the name, age range and address of your school and what is your position?
2. Which healthcare professionals regularly work with the children at your school?
3. Do the children have their vision assessed in school?
4. Does the vision assessment require parental consent?
5. What checks are normally involved in the vision assessment?
6. Who usually carries out the vision assessment for the children?
7. Is there a report issued following the assessment for each child?
8. Who normally receives a copy of the report after the vision assessment?
9. If a child has been identified as having vision problems does the report include modifications that can be made either to the child's schoolwork or to the classroom?
10. In which Key Stage(s) does the vision assessment take place?
11. Do you think it is useful for children to have their vision checked regularly throughout their time at school?
12. Are there eyecare professionals available at the school to provide support to pupils who may have a visual impairment?

To ensure questions and terminology would be understood by school staff, guidance was taken from a Vice-Principal of a local special school. Definitions of eye care professionals and their job role were included in the information sheet attached to the survey.

2.2.3. Recruitment

Details of all special schools in Northern Ireland were obtained from the Department of Education Statistics and Research department (School enrolments, 2016). In late November 2016, a letter of invitation was sent to Principals of all 39 schools inviting them to participate in the study. In January 2017 each Principal (or schools medical coordinator) was emailed with a link to the online survey. A reminder email was issued a week before the deadline date. When the deadline had passed, schools from which no response had been received were sent a postal version of the survey with a stamped addressed envelope for its return (Appendix 2). After a couple of months, a second survey reminder was posted together with a copy of the survey and a stamped addressed envelope.

2.3. Results

Thirty-six of the 39 schools completed the survey representing an overall response rate of 92%. Participating schools represent 4634 of the 5173 pupils that are enrolled in special schools in Northern Ireland and therefore represent 90% of the special school population. Nineteen schools (52.7%) completed the postal version of the survey and 17 schools (43.6%) completed the survey via the online link.

2.3.1. The Respondents

Figure 2.1. shows the distribution of the schools and the number of children they represent in relation to the Trust that provides their healthcare.

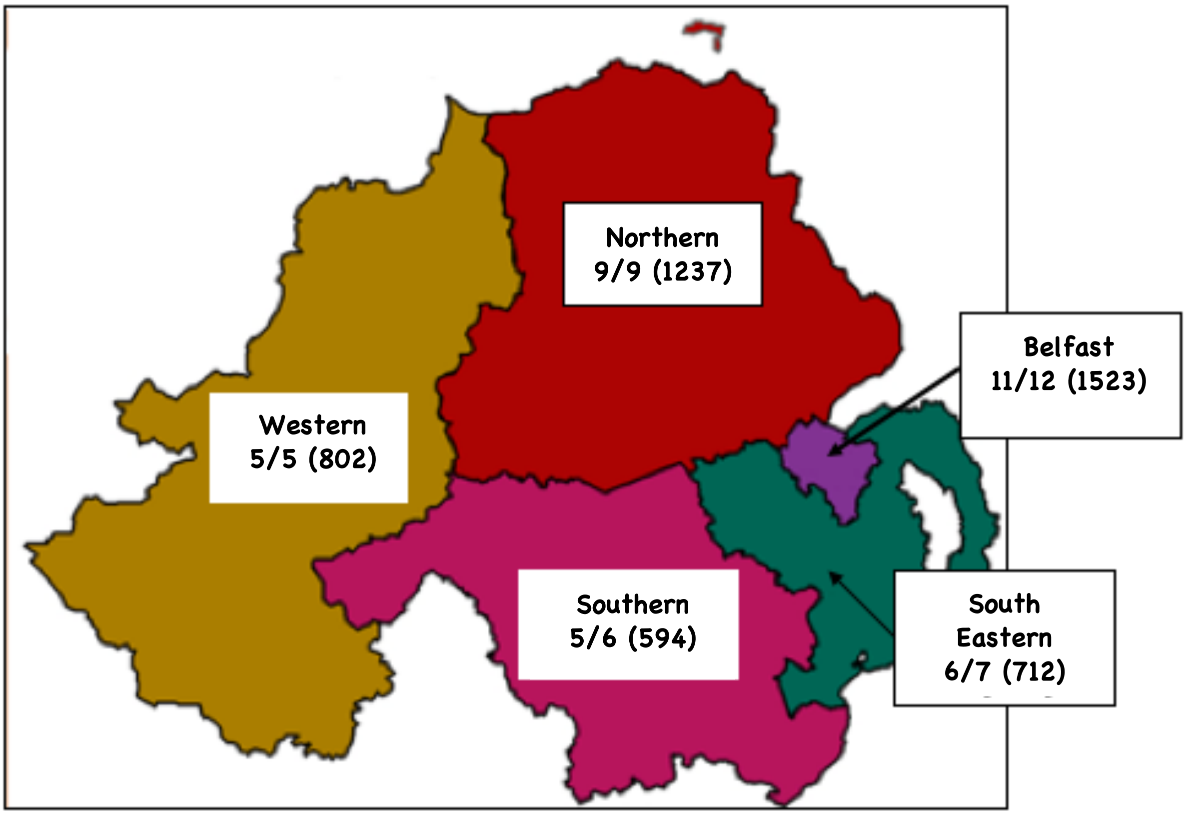


Figure 2.1. *Distribution of schools and the no. of children they represent (n) across the Health and Social Care Trusts in Northern Ireland.*

The age range of the children attending the schools who responded to the survey is summarised in Table 2. The majority of schools educate children aged between 3-19 years old.

Age range of children educated at the school (years old)	No. of schools
3-19	19
4-19	3
4-16	3
11-19	2
3-6	1
3-8	1
3-11	1
3-16	1
3-17	1
6-11	1
8-19	1
11-14	1
11-18	1

Table 2. *Age range of pupils attending the 36 special schools in Northern Ireland who responded to the survey*

Sixty-one percent of the surveys were completed by the Principal, 27% by the Vice-Principal, 6% by a senior teacher, 3% by a co-ordinator of multisensory department, 3% by the head of pastoral care, 3% by the school nurse and 6% did not specify the designation of the respondent.

2.3.2. Healthcare professionals represented within Special Schools

Table 2.1. details the percentage and number of schools that have access to healthcare professionals on a regular basis. Variations in the accessibility of these healthcare professions become apparent when the schools are grouped by healthcare Trusts. However, only the variation of orthoptists and optometrists between Trusts, is **statistically significant.** Orthoptists are more likely to regularly attend special schools in the Southern and Western Trust (**$p<0.001$**; Kruskal-Wallis, $\chi^2[4]=23.136$) and

optometrists are more likely to be represented at special schools in the Western Trust (**p=0.021**; Kruskal-Wallis, $\chi^2[4]=11.516$).

Healthcare professional	Percentage (no.) of schools with the healthcare professional attending on a regular basis					
	Overall (n=36)	Belfast (n=11)	Northern (n=9)	Western (n=5)	Southern (n=5)	South Eastern (n=6)
School Nurse	69%	82%	56%	80%	60%	67%
Speech and Language Therapist	89%	82%	100%	100%	100%	67%
Physiotherapist	61%	45%	78%	80%	80%	33%
Occupational Therapist	75%	73%	67%	100%	100%	50%
Community Paediatrician	39%	55%	44%	20%	60%	0%
Behavioural Psychologist	22%	18%	33%	40%	0%	17%
Ophthalmologist	6%	9%	0%	20%	0%	0%
Dental Services	6%	0%	0%	20%	0%	17%
Hearing Services	6%	9%	0%	0%	0%	17%
Orthoptist*	22%	9%	0%	40%	100%	0%
Optometrist*	14%	0%	13%	60%	20%	0%

Table 2.1. *Representation of healthcare professionals in special schools in Northern Ireland. *=Statistically significant inter-Trust differences.*

2.3.3 In-school vision services

Fifty-eight percent of respondents reported that in-school vision services were available in their school. Of these schools, 91% reported that the vision assessment required parental consent, one school indicated no consent was required and the remaining school was unsure if the assessment required consent or not.

All schools in the Western and Southern Trusts have an in-school vision service available compared with half the schools in the Belfast Trust and a third of schools in the Northern and South Eastern Trusts (Table 2.2). Children attending special schools in the Western and Southern Trusts are statistically significantly more likely to be offered in-school vision assessment compared with children attending schools within the other Trusts in Northern Ireland (**p=0.029**; Kruskal-Wallis, $\chi^2[4]=10.758$).

	Percentage (no.) of schools					
Are in-school vision services available?	Overall (n=36)	Belfast (n=11)	Northern (n=9)	Western (n=5)	Southern (n=5)	South Eastern (n=6)
Yes	58%	55%	33%	100%	100%	33%
No	42%	45%	67%	0%	0%	67%

Table 2.2. *The availability of in-school vision services in Northern Ireland special schools*

2.3.4. What checks are normally carried out as part of the vision service and who performs the assessment?

Table 2.3. details the professionals reported by respondents to be conducting in-school vision assessments and the measures included. No additional tests to those listed in the survey were reported to have taken place. Of the twenty-one schools that reported in-school vision services, thirteen documented the checks involved in their school's vision assessment, however eight schools (highlighted in yellow) were unsure of the checks involved.

100% (13/13) of schools reported that a measure of vision was a component of the visual assessment, 69.2% reported a binocular vision assessment, 52.6% an internal eye health check, 36.8% a check for the need of glasses and 15.8% reported colour vision assessment.

	School	Professional	Vision assessment checks				
			Vision measure	Binocular assessment	Internal eye health check	Need for glasses	Colour vision assessment
	BS1	School Nurse	?	?	?	?	?
	BS2	School Nurse	✓				
	BS3	Ophthalmologist/ Orthoptist	✓	✓	✓	✓	
	BS4	School Nurse	?	?	?	?	?
	BS5	School Nurse/ QTVI	✓	✓		✓	
	BS6	School Nurse	?	?	?	?	?
	NS1	School Nurse	?	?	?	?	?
	NS2	Ophthalmologist	✓	✓	✓	✓	✓
	NS3	School Nurse/ Paediatrician	✓	✓	✓		
	SES1	QTVI	✓		✓		
	SES2	-	✓	✓	✓		
	SS1	Orthoptist	?	?	?	?	?
	SS2	Orthoptist	?	?	?	?	?
	SS3	Orthoptist	?	?	?	?	?
	SS4	Optometrist/ Orthoptist	✓	✓	✓		
	SS5	Optometrist/ Orthoptist	?	?	?	?	?
	WS1	Optometrist	✓		✓	✓	
	WS2	Optometrist	✓	✓	✓	✓	
	WS3	Orthoptist	✓	✓	✓	✓	✓
	WS3	Optometrist/ Orthoptist	✓	✓	✓	✓	✓
	WS4	Orthoptist	?	?	?	?	?

Table 2.3. *Reported in-school vision assessment checks and the personnel performing them.* ■ *Belfast Trust,* ■ *Northern Trust,* ■ *South-Eastern Trust,* ■ *Southern Trust,* ■ *Western Trust. N.B.* ✓=Yes, x=No, ?=Not Known.

Twenty of the twenty-one respondents identified the professionals responsible for performing in-school vision services. 40% (8/20) of schools reported that in-school vision assessments were performed by non-eyecare professionals i.e. school nurse/Qualified Teacher of Visual Impairment (QTVI)/paediatrician whilst the remaining 60% (12/20) reported such assessments to be conducted by eyecare professionals, i.e. ophthalmologists/optometrists/orthoptists. All vision assessments in the Southern and Western Trusts were reported to be performed by eyecare professionals whereas in the Northern, Belfast and South-Eastern Trusts they were mainly performed by non-eyecare professionals.

2.3.5. Reporting and dissemination of vision assessment results

81% (17/21) of schools with in-school vision assessments report that results are shared in a report written following in-school vision assessment. 23.5% were issued by the School Nurse, 23.5% by an Orthoptist, 11.8% by a QTVI, 11.8% by an Optometrist, 11.8% by an Optometrist/Orthoptist team, 5.9% by an Ophthalmologist, 11.8% by an Ophthalmologist/Orthoptist team and 11.8% unknown. Table 2.4. illustrates who written reports are disseminated to in each school and whether or not classroom modifications were recommended to account for visual deficits detected if required.

School	Professional issuing report	Report issued	Who receives the report?						Are classroom modifications recommended if required?
			Pa	Pr	T	Ca	Nu	Sen	
BS1	School Nurse	✓	✓						I've never seen the report
BS2	School Nurse	✓	✓						x
BS3	Ophthalmologist/ Orthoptist	✓	✓						I've never seen the report
BS4	School Nurse	✓	✓						I've never seen the report
BS5	School Nurse/ QTVI	✓					✓	✓	✓
BS6	School Nurse	✓	✓	✓					
NS1	School Nurse	?							?
NS2	Ophthalmologist	✓	✓	✓					✓
NS3	School Nurse/ Paediatrician	x							
SES1	QTVI	✓	✓	✓					✓
SES2	-	✓	✓	✓			✓		✓
SS1	Orthoptist	✓	✓	✓	✓	✓			✓
SS2	Orthoptist	✓		✓	✓				✓
SS3	Orthoptist	✓		✓					✓
SS4	Optometrist/ Orthoptist	✓	✓	✓	✓				✓
SS5	Optometrist/ Orthoptist	✓	✓	✓	✓				x
WS1	Optometrist	✓	✓						✓
WS2	Optometrist	✓	✓						✓
WS3	Orthoptist	✓	✓		✓				✓
WS3	Optometrist/ Orthoptist	x							
WS4	Orthoptist	?							?

Table 2.4. *Issuing and dissemination of reports following in-school assessment., P=Parent, Pr=Principal, T=Teacher, Ca=Classroom assistant, Nu= School Nurse, Sen= Special Educational Needs CoOrdinator (SENCO); ■ Belfast Trust, ■ Northern*

Trust, ■ *South-Eastern Trust,* ■ *Southern Trust,* ■ *Western Trust. N.B.* ✓=Yes, x=No, ?=Not Known.

Fifteen of the seventeen (88.2%) schools responded to the question on whether the reports received from the in-school vision assessment included classroom modification recommendations if required to account for visual deficits. 73.3% of schools (11/15) reported that such recommendations were included in the report (Table 2.4.).

2.3.6. When do the vision assessments take place?

Forty-nine percent (9/21) of schools reported that vision assessments occur for children at all key stages in their school career i.e. not just at school entry. Table 2.5. details the key stages (and corresponding ages of the children) at which in-school vision assessment are offered in all schools. In instances where the school doesn’t educate pupils within the key stage age range, this is annotated as N/A.

	School	Vision Assessor	Early Years *(4-6yrs)*	KS1 *(6-8yrs)*	KS2 *(8-11yrs)*	KS3 *(11-14yrs)*	KS4 *(14-16yrs)*	KS5 (≥16yrs)
	BS1	School Nurse	✓	x	x	x	x	N/A
	BS2	School Nurse	N/A	x	✓	N/A	N/A	N/A
	BS3	Ophthalmologist/ Orthoptist	✓	x	x	x	x	x
	BS4	School Nurse	✓	x	N/A	N/A	N/A	N/A
	BS5	School Nurse/ QTVI	✓	✓	✓	✓	N/A	N/A
	BS6	School Nurse	✓	x	x	x	x	N/A
	NS1	School Nurse	x	✓	x	✓	x	x
	NS2	Ophthalmologist	✓	✓	✓	✓	✓	✓
	NS3	School Nurse/ Paediatrician	✓	✓	✓	x	x	x
	SES1	QTVI	✓	x	x	x	x	x
	SES2	-	✓	✓	✓	✓	✓	✓
	SS1	Orthoptist	x	✓	✓	✓	✓	✓
	SS2	Orthoptist	✓	✓	✓	✓	✓	✓
	SS3	Orthoptist	x	✓	✓	x	x	x
	SS4	Optometrist/ Orthoptist	✓	✓	✓	✓	✓	✓
	SS5	Optometrist/ Orthoptist	✓	✓	✓	✓	✓	✓
	WS1	Optometrist	✓	✓	✓	✓	✓	✓
	WS2	Optometrist	✓	✓	✓	✓	✓	✓
	WS3	Orthoptist	✓	✓	✓	✓	✓	✓
	WS3	Optometrist/ Orthoptist	x	✓	✓	✓	✓	✓
	WS4	Orthoptist	x	✓	✓	✓	✓	✓

Table 2.5: *The key stages in which vision services are conducted in schools.* ■ *Belfast Trust,* ■ *Northern Trust,* ■ *South-Eastern Trust,* ■ *Southern Trust,* ■ *Western Trust*

2.3.7. How useful respondents think regular in-school vision assessment is for the child

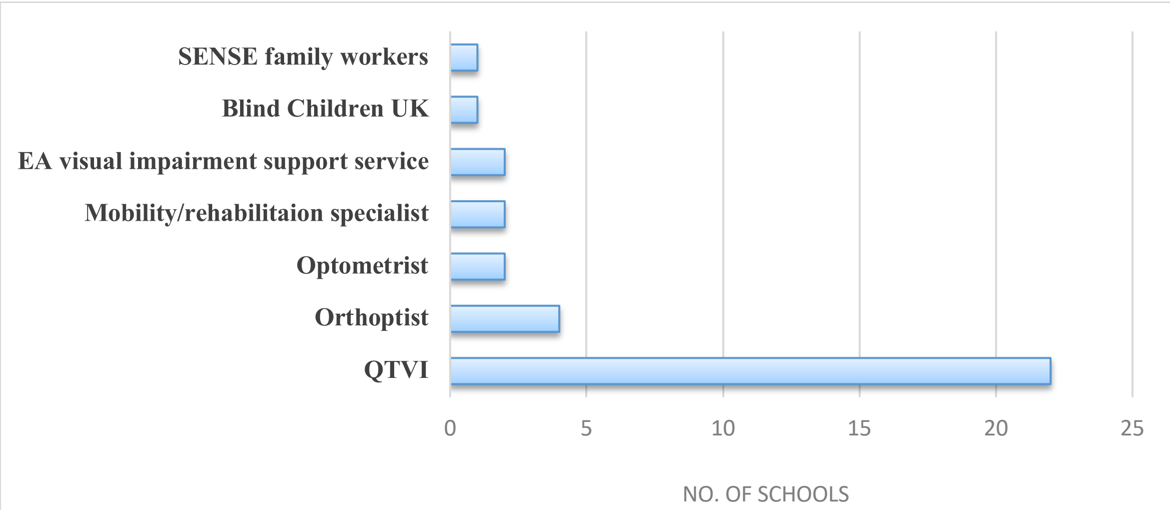
One hundred percent of schools reported that children having their vision checked regularly throughout their time at school is useful. Comments made as to why schools felt regular eye tests are useful and are detailed in Table 2.6.

Reasons why schools find regular eye tests for the children at school useful
"Vision could be affecting their learning"
"Pupils have severe learning difficulties and sometimes simple checks like eye sight can get missed"
"Vision can fluctuate/ change or be an indicator of other health issues"
"To assess any ongoing problems"
"Pupils with SLD would not communicate if there were visual difficulties"
"Can be difficult for parents to take a child with SEN to the optician"
"Many parents don't visit an optometrist regularly- issues are missed"
"Dyslexic tendencies"
"Some of our pupils find going to appointments like this to be stressful (for their parents too) and we can offer support here
"Due to communication difficulties it is often very difficult for us to be sure of changes in vision"
"Important to ensure materials etc. are prepared and suitable for pupils"
"It is often less stressful for the parents and the children to have appointments like this in school"
"Parents may not bring them to the hospital"

Table 2.6. *Comments from schools who believe regular eye tests at school are useful.*

2.3.8 Eyecare professional support available to those with a visual impairment

Two-thirds of schools surveyed completed this question. The professionals available to provide support to children with visual impairment at schools in Northern Irelands are illustrated in Graph 2. QTVIs provide the majority (61.1%) of support in schools to children with a visual impairment.



Graph 2. *Support available at schools to those with a visual impairment*

2.4. Discussion

The current study's key finding is that there is **inequity** in the provision of in-school vision services within special schools in Northern Ireland. This inequity is highlighted in 3 main areas:

1. The availability of in-school vision services
2. The specific expertise of the professionals delivering vision assessments
3. The extent to which eye health and visual status are investigated and outcomes communicated to stakeholders

2.4.1. Inequity of the availability of in-school vision assessment

Forty-two percent of schools surveyed report no form of in-school vision assessment. This is consistent with findings from studies in Wales and England of which 47% and 59% of schools have no in-school vision care respectively (Woodhouse *et al*., 2014; Donaldson *et al*., 2019). The findings from the present study identify that over two thousand children in Northern Ireland are potentially missing out on valuable eyecare. Other sources of eyecare are available at hospital clinics or local opticians, however other studies in the UK report a lack of uptake of such services (Piling *et al*., 2017; Woodhouse *et al.,* 2014; Donaldson *et al.,* 2019). Pilling *et al.* (2017) reported that a quarter of children in Bradford who were referred for further tests following an initial in-school vision assessment failed to attend their appointment. Comments from schools in the current study provide some insight into the reasoning behind this "It can be difficult for parents to take a child with special educational needs to the optician" and "some of our pupils find appointments like this to be stressful (for the parents too)".

To date, there are no data available in the literature to confirm whether this group of Northern Irish children are accessing this eye care outside of school.

2.4.2. Inequity of specific expertise of the professionals delivering vision services

The main professionals involved with in-school vision services in Northern Ireland were identified as being orthoptists, school nurses and optometrists. Woodhouse et al. (2014) published similar findings (table 2.7.) although more QTVI's are involved in vision assessment in Wales than in Northern Ireland.

Vision assessor	SEE Project, NI	Woodhouse et al., 2014
School Nurse	33%	37%
Orthoptist	29%	47%
Optometrist	19%	16%
Ophthalmologist	10%	-
QTVI	10%	32%
Paediatrician	5%	-

Table 2.7. *Distribution of vision assessors across special schools in Wales and Northern Ireland*

Across all of the professions that regularly work within special schools, orthoptists and optometrists are the only profession in which their representation significantly differs between Trusts. This may be due to the Western and Southern Trusts prioritising paediatric eyecare or this may be due to limited numbers of orthoptists and optometrists working within Northern Ireland's five healthcare Trusts (Table 2.8.). Although there are 685 optometrists registered in Northern Ireland (Business Services Organisation 2017), only 8% work in hospital settings (Northern Ireland Statistics and Research Agency 2017). Screening and visual assessment of young children and children with special needs are traditionally orthoptic-led. Optometrists in Northern Ireland are rarely deployed from the health Trusts or commissioned from primary care to conduct initial visual screening at special schools, leaving a rich resource untapped.

	Representation within Trusts (2017)					
	Overall	Belfast	Northern	Western	Southern	South Eastern
Orthoptists and orthoptic support staff	44	7	13	11	6	7
Hospital optometrists	52	41	0	11	0	0

Table 2.8: *Hospital-based Workforce: Orthoptists and optometrists working within Northern Ireland's healthcare Trusts (Northern Ireland Statistics and Research agency, 2017)*

2.4.3. Inequity in the extent to which eye health and visual status are investigated and outcomes communicated to stakeholders

The measures conducted as part of the in-school vision assessment and the reporting outcomes lack consistency in Northern Ireland. All schools in the Southern and Western Trust report in-school 'enhanced visual screening' conducted by an eyecare professional. In contrast, few schools situated in the Belfast, South Eastern and Northern Trusts are offered in-school eyecare, those that are have basic screening conducted by non-eyecare professionals.

The Orthoptic Leads for the in-school vision screening in the Southern and the Western Trusts participated in The SEE Project Stakeholder Day discussion panel entitled "Vision provision in Special Education- a UK perspective" on the 7th December 2018 (Boyle, 2018). Both orthoptists reported that each child seen within their services has an initial assessment conducted by an orthoptist.

In the Southern Trust, the orthoptist reported that the initial assessment consists of a visual acuity measure at distance and near using a suitable test, assessment of ocular movements, smooth pursuits and saccades, convergence, fusion and stereopsis in addition to a measure of accommodation and confrontation. Optometric assessment, i.e. cycloplegic refraction and an ocular health check, is only provided when judged clinically necessary by the orthoptist. Children with Down syndrome, however, are the exception and have a refraction every two years regardless of acuity. An approach such as this, without any clear evidence-based criteria, ignores recommendations of a full eye examination for **all** children within this group (Hall &Elliman, 2006).

Reports issued following the assessment includes the results of tests; explaining any visual difficulties the child may have and advice on how to adapt education/ school material to help. A copy of the report is disseminated to the teacher, paediatrician, school nurse team and any in-school therapists or QTVIs that work with the child.

Despite these detailed reports being issued, 80% (4/5) of school survey responses from the Southern Trust highlight a lack of appreciation of the measures involved in the visual assessment, suggesting the reports are not read or optimally understood. However, one of the Principals commented *"the orthoptist sends detailed reports, but teachers would depend on her flagging up issues"*.

In the Western Trust, the Orthoptic-Lead stated that all children in primary one or anyone who is new to the school that academic year are offered an initial assessment. The initial assessment consists of a visual acuity check using a test appropriate for age and ability, cover test (distance and near), ocular motility, ocular movements, fusion, stereopsis and suppression tests. If the child is unable to achieve at least 0.2logMAR acuity in either eye using a crowded logMAR letter test they are then offered a dilated ocular health and refraction assessment by the optometrist. Using these criteria, children with SpEN are more likely to be provided with a full eye examination as Donaldson *et al.* (2019) and Ankeltell e*t al.* (2018) report that only 6.4 to 37.5% of children with SpEN were capable of completing the crowded logMAR acuity test. Nevertheless, those who are capable of

completing the crowded acuity test and ‘pass’ will miss out on a refraction and ocular health assessment which increases the risk of visual deficits being overlooked.
The Orthoptist explained how in the Western Trust, reports are generated following each assessment (including recommended classroom adaptations if appropriate) and are sent to parents, teachers, optometrists, social workers, GPs and QTVIs, as required. Despite this, only one school in the Western Trust stated that either the teachers or the Principal received a copy of a vision report.

A primary care Optometrist practice was identified in the survey as providing eye examinations at one school in the Southern Trust. Personal communication was made with the company’s customer care co-ordinator (March 2018). The Optometrists provides in-school NHS eye examinations if requested by the school. Each eye examination consists of a visual acuity measure, refraction, binocular assessment and an ocular health assessment. If any additional tests such as cycloplegic refraction or visual fields are required, the child is directed to one of Optometrists’ high street optical practices for further investigation. An in-school spectacle dispensing service is offered and pictures of the child wearing different spectacles are sent home to the parent for approval. Reports issued to the school’s medical coordinator following the assessment to be distributed to parents and include information regarding the child’s general health, spectacle prescription, how that prescription was obtained and whether or not glasses were prescribed. No other results from visual tests were included on this report which may be why the responding school was unsure of the measures involved in the visual assessment.

School nurses are trained by orthoptists to provide a vision screening service in mainstream schools across Northern Ireland, as recommended by the National Screening Committee i.e. monocular crowded logMAR letter visual acuity test. A letter is generated following the screening to inform the parent whether the child has 'passed' or 'failed' the screening required further investigation. Two special education schools who participated in the present study report that assessments were performed by school nurses. They indicated that additional measures were made by the school nurse, including the need for glasses and binocular vison assessment however this is not within the school nurse's scope of practice.

Over 80% of schools who reported that in-school vision screening took place in their institution stated that a report was issued by the professional after the in-school vision assessment. However it is clear that the information delivered in these reports are not consistent and children's visual deficits are being communicated and addressed better in some areas of Northern Ireland compared to others, despite the UK government policy which promotes equality in healthcare (Children and Families Act, 2014; Children's Services Co-Operation Act (Northern Ireland), 2015).

Neither the standard vision screening, 'enhanced visual screening' or eye examination offered by the primary care Optometrists, include a routine measure of **contrast sensitivity** and **cycloplegic refraction** on all children despite a higher prevalence of refractive error and reduced contrast sensitivity being reported in a SpEN population (Nielsen *et al.,* 2007; Das *et al.,* 2010; Pilling *et al.,* 2017, Kaur *et al.,* 2016; Puri *et al.,* 2015; Gogri *et al.,* 2016).

2.5. Strengths

This is the first study to reveal the inconsistences between the in-school vision services offered to special schools from the five Health Trusts in Northern Ireland, which, until now were unconfirmed.

2.6. Limitations

The author did not have first-hand experience of the different in-school eyecare models provided in Northern Ireland. Information gathering relied on self-reporting from schools.

2.7. Conclusion

Currently there is a "postcode lottery" of in-school eyecare provision across Northern Ireland. Children attending special schools within the Southern and Western Trusts are more likely to receive in-school 'enhanced vision screening' than those attending schools in other Trusts. Information regarding the outcomes from these screenings are not uniformly communicated and disseminated.

Chapter 3 Techniques used in visual function assessment and ocular health investigations

This chapter describes all the visual function and ocular health investigations employed in the feasibility study and SEE project.

3.1. Introduction

The SpEN population includes children with a range of abilities and therefore conventional measures of visual function are not always appropriate. Choosing alternative tests which are more suited to the child's age and ability ensures that results are a true reflection of the child's threshold.

This chapter will describe the tests used to measure the visual function and investigate ocular health of this population and includes corresponding normative data.

3.2. Tests used to evaluate visual function

The following are measures used to assess visual function:

i. Visual acuity
ii. Contrast: contrast sensitivity and contrast acuity
iii. Binocular function: ocular alignment, eye movement and control, accommodative function, stereoacuity
iv. Visual field
v. Colour vision
vi. Refraction

3.2.1. Visual acuity

3.2.1.1. Cardiff acuity test

This preferential looking test can provide a measure of acuity at 1m or 50cm (Figure 3.).

There are eleven visual acuity levels ranging from 6/60 to 6/6 at 1m (6/120 to 6/12 at 50cm) with three cards at each level. Each card was presented at the child's eye level. The examiner watched the participant's eye movement and compared this to the position of the picture on the card to which they were blind. When two of the three cards were consistently seen correctly the next acuity level was presented.

This test was used on participants who were non-verbal and/or unable to match, name or sign symbols or letters.

Figure 3. *A participant pointing to the position of the picture on the Cardiff acuity test card while [1]SAB judges the response of the participant's fixation.*

3.2.1.2. LEA single and crowded symbol test

The LEA crowded test is a logMAR test. The 13-line chart ranging from 0.8logMAR to -0.4logMAR (Figure 3.1) was illuminated by a small light box and set at a distance of 3m. The examiner briefly pointed to the first symbol in each line, moving down the chart until the participant misidentified the symbol. The participant was then asked to identify the symbols on the line above. Visual acuity was recorded as the last line on which at least three out of five symbols where identified correctly.

Figure 3.1. *The LEA 13-line crowded test illuminated by a small light box*

In instances where a child was unable to identify the symbols displayed in a crowded format, the LEA symbols single booklet was used ranging from 1.0logMAR to -0.3logMAR. If two out of the four symbols at the same acuity level were identified correctly, the examiner then showed one of the symbols a second time to give a fifth choice. The visual acuity threshold was deemed to be the smallest symbol size at which the participant successfully identified three out of the five symbols.

This test was selected for children who were able to match, name or sign the symbols but unable to match, name or sign letters.

3.2.1.3. Sonksen single and crowded letter test.

Children were presented the single letter booklet test displays at 3m starting with the 0.8logMAR letter until the letter was not seen correctly. Using the crowded test booklet the participant was first shown the level two lines above the single acuity level. The child was shown each line in turn until three consecutive letters were failed. Visual acuity was recorded using letter per letter scoring system, where each letter had a value of 0.025. Both tests letters ranged from 0.8logMAR to -0.3logMAR.

This test was selected for children who were able to match, name or sign letters.

3.2.1.4. LEA crowded near acuity test.

The chart ranges from 0.7logMAR to -0.1logMAR and was held at 40cm. The participant was asked to identify the first symbol on each acuity line until misidentifying the symbol and was then asked to identify the symbols on the line above. Visual acuity is recorded as the last line on which at least three of the five symbols are correctly identified.

3.2.1.5. Sonksen near acuity test chart.

The participant was asked to identify the first letter in each acuity line until misidentifying the letter and then was shown two lines above this acuity level. The participant was asked to identify each line until three consecutive letters were failed. Visual acuity was recorded letter by letter where each letter had a value of 0.025logMAR. Acuity levels ranged from 1.3logMAR to 0.00logMAR.

In cases where a formal measure of visual acuity could not be made using one of the above methods, the participant's visual function was assessed using the Bradford Box (Pilling *et al.,*2016). Objects of decreasing size and colour were presented to the child and the response was observed and recorded.

3.2.1.6. Normative data for visual acuity measures

Table 3. details the normative values for each visual acuity chart and the supporting literature

Test Chart	**Normative values**				**Supporting literature**
	Age	VA (logMAR)	% of 'visually normal' children that will have acuity of this level	Monocular/ Binocular	
Cardiff acuity test (preferential looking) at 50cm and 1m	30-36 months	≤ 0.300	95%	Monocular and Binocular	*Adoh, Woodhouse, 1994*
LEA single optotypes at 3m	37-48 months	≤ 0.000	90%	Monocular	*Becker et al., 2002*
	49-60 months	≤ 0.100			
	60-93 months	≤ 0.000			
LEA crowded at 3m	3-9 yrs.	≤ 0.200	95%	Monocular	*Little JA et al., 2013*
	≥10 yrs.	≤ 0.100			
Sonksen crowded at 3m	3 yrs.	≤ 0.325	95%	Monocular	*Sonksen et al., 2008*
	4 yrs.	≤ 0.200			
	5 yrs.	≤ 0.125			
	6 yrs.	≤ 0.075			
	≥ 7 yrs.	≤ 0.050			
LEA crowded near chart at 40cm	3-6 yrs.	≤ 0.075	95%	Binocular	*Huurneman et al., 2016*
	6-9 yrs.	≤ -0.075			
	10 yrs.	≤ -0.100	93%	Binocular	*Larsson et al 2005*
Sonksen crowded near chart at 40cm	5-6 yrs.	< 0.375	95%	Binoc	*Ntodie, 2019*
	7-8 yrs.	< 0.125			
	9-10 yrs.	< 0.375			

Table 3. *Normative visual acuity values for each of the test chart's utilised.*

3.2.2. Contrast

3.2.2.1. Cardiff Contrast Sensitivity Test

Contrast sensitivity was measured binocularly using the Cardiff Contrast Sensitivity Test at 50cm. There are twelve levels ranging from 2.17 to 100 with three cards at each level. Each card was presented at the child's eye level. The examiner monitored the participant's eye movement and compared this to the position of the picture on the card. When two of the three cards were consistently seen correctly the next contrast level was presented.

3.3.2.1.1. Cardiff Contrast Sensitivity Test normative data

Table 3.1. details the normative contrast sensitivity values for children aged ≥ 3 years old (Barbareza *et al.,* 2008).

Age group	Contrast Sensitivity
3-4 years	at least 33.33
4 and beyond	at least 50

Table 3.1. *Normative contrast sensitivity values for children aged three and over.*

3.2.2.2. Low contrast LEA 2.5% crowded symbol test

The LEA low contrast 2.5% crowded test is a logMAR test. The 13-line chart ranging from 0.8logMAR to -0.4logMAR was illuminated by a small light box and set at a distance of 3m. The examiner briefly pointed to the first symbol in each line, moving down the chart until the participant misidentified the symbol. The participant was then asked to identify the symbols on the line above. Visual acuity was recorded as the last line on which at least three out of five symbols were identified correctly.

3.2.2.2.1. Normative values for Low contrast LEA 2.5%

A difference of 0.4logMAR or less between LEA high contrast and LEA low contrast (2.5%) crowded symbol test is considered normal (Little *et al*., 2013).

3.2.3. Binocular Function

3.2.3.1. Ocular alignment

A prism cover test was performed using fixation targets at 3m (distance) and 40cm (near) (Rowe, 2012).

3.2.3.2. Eye movement and control

3.2.3.2.1. Ocular motility

Ocular motility was assessed by directing the participant to follow light from a pen torch as it moved into eight positions of gaze. The examiner objectively assessed the quality e.g. 'smooth', 'jerky' and extent of movement e.g. 'full', 'constricted on lateral gaze' (Rowe, 2012).

3.2.3.2.2. Pursuits

The participant was instructed to follow the light from a pen torch at a distance of 40cm as it moved from each side of the head (horizontally) and above the head (vertically). The examiner objectively assessed the quality of movement (Rowe, 2012).

3.2.3.2.3. Saccadic movement

The participant was asked to look at the light of one pen torch at a distance of 40cm to the light of another held 20cm apart. One pen torch was held in the primary position and the other to each side of the head for horizontal movement and above and below the head for vertical movement. The examiner objectively assessed the accuracy and speed of saccadic eye movement (Rowe, 2012).

3.2.3.2.4. Near Point of Convergence (NPC)

The participant was instructed to look at a picture on a fixation stick held in the primary position at 30cm away from the participant. The examiner brought the stick gradually towards the participant's eyes until a break in convergence was noted or diplopia was reported (Rowe, 2012). Jimenez et al. (2004) report 6cm or less for NPC break, as being clinically normal.

3.2.3.3. Accommodative function

Accommodative function was assessed using the Ulster-Cardiff accommodation cube (Figure 3.2). The participant viewed an internally illuminated, visually detailed target at a fixed distance of 25cm. The examiner moved the retinoscope to the distance where the reflex was neutralised.

Accommodative response to a 4D (25cm) target was considered accurate if between 2.94 and 4.46D (McClelland & Saunders, 2004).

Figure 3.2. [1]*SAB measuring accommodative ability through a participant's bifocal segment using the UC-cube*

3.2.3.4. Stereoacuity

Stereoacuity was assessed using the Frisby Near Stereotest containing one demonstration plate and three test plates of varying thicknesses (6mm, 3mm and 1.5mm).

Test understanding was established using a practice plate held steadily in front of a white background in-line with the participant's head. The demonstration plate contained the outline of four boxes, one of the boxes contained a circular, patterned target (figure 3.3).

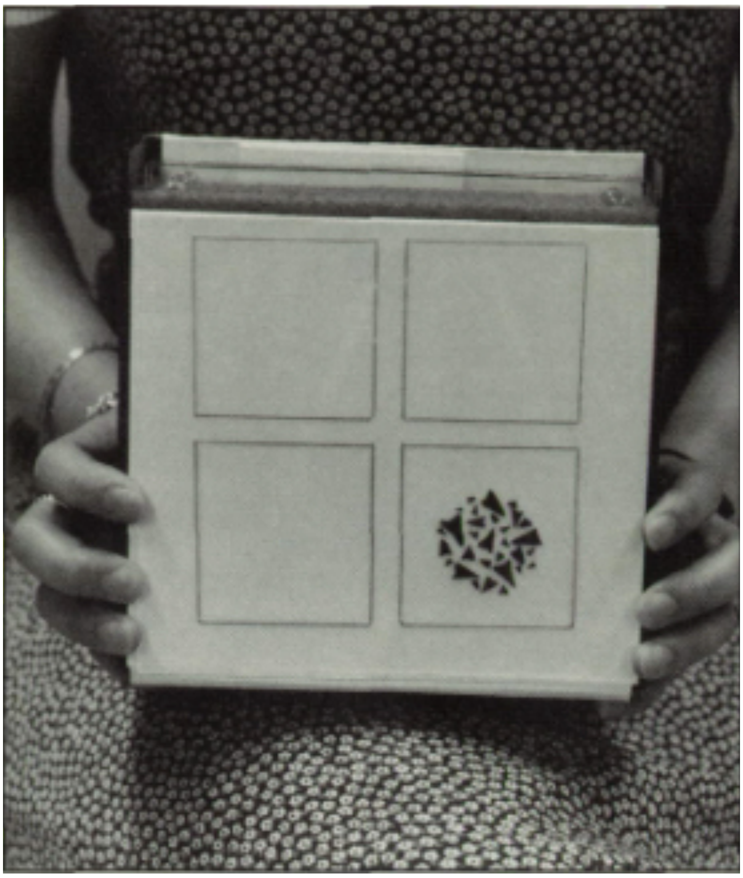


Figure 3.3. *Image taken from "The Modified Frisby stereotest" Saunders et al. (1996) demonstrating the practice plate.*

The participant was asked to "find the ball" by pointing to or touching the plate. If the participant did not volunteer a clear pointing or touching response, the tester could instead observe scanning eye movements. If scanning eye movements stopped consistently at the correct square, this was recorded as a positive result. The plate was then turned so that the target was in a different position and the participant was again asked to "find the ball".

Younger children were given an "auditory reward" by the tester for the correct identification of the target (e.g. the squeak of a toy) as this was shown by Saunders *et al.* (1996) to boost cooperation.

Once understanding was established, the practice plate was replaced with the thickest plate and the participant was again asked to "find the ball", first in the crossed presentation (ball appears to 'pop' out of the box) and then in the uncrossed presentation (ball appears to 'sink' into the box). If three or four accurate responses were made for each presentation the 3mm thickness plate was shown and if accurate responses were made again the final 1.5mm plate was shown until the lowest disparity value was reliably measured from the participant. Table 3.2. gives the disparity values for each plate at varying viewing distances.

	Plate thickness		
Viewing distance (cm)	6mm	3mm	1.5mm
30	600"	300"	150"
40	340"	170"	85"
50	215"	110"	55"
60	150"	75"	40"
70	110"	55"	30"

Table 3.2. *Stereoacuity values of plates at varying distances*

Stereoacuity was defined as being normal if better than or equal to 85", when displayed in 'crossed' presentation, in both primary and post-primary children (Anketell *et al*., 2013).

3.2.4. Visual field

Visual field testing was measured using a 5cm diameter Stycar ball and the confrontation method (Sheridan, 1973) One investigator sat opposite the participant and attracted the participant's attention using a toy. Another investigator stood behind the participant and brought the ball, secured to a rod, into the participants visual field from various positions. The investigator sitting opposite the participant, observes the moment when the participant first sees the ball as shown in Figure 3.4.

Figure 3.4. *[1]SAB brings the stycar ball from behind to the participant's left side whilst [2]ELM observes the moment the participant first sees the ball.*

3.2.5. Colour vision

The CVTME test was used to identify the presence of red/green colour deficiencies and comprises of two sections. Section 1 consists of 10 plates, the first being a demonstration plate containing symbols visible to all colour- deficient and those with normal colour vision. The remaining nine plates each contain two or three of these symbols, one or more of which cannot be detected by a colour-deficient observer, but all will be seen by those with normal colour vision. Participants were encouraged to name the shapes seen on each plate or to point to the shapes named by the examiner. Those with normal colour vision should correctly identify eight out of nine test shapes on the first attempt or all test shapes on the second attempt. Section 2 of the CVTME test consists of four plates and is more suited to younger participants and those with more severe learning difficulties. The first demonstration plate contains black and white images of a dog, car, boat and balloon. The participants were shown the demonstration plate and asked to name the black and white images to ensure they were familiar with them. They were then shown the three colour test plates which show the dog, boat and balloon. Participants with normal colour vision should correctly identify all three figures (Richardson *et al*., 2008).

3.2.6. Cycloplegic refraction

Cycloplegic refraction was performed on participants, with parental permission, to determine magnitude of refractive error. A history was taken from parents to ensure the lack of any contraindications or previous adverse reactions to the drug. Cyclopentolate Hydrochloride 1% was instilled in each eye. After 30 minutes retinoscopy was performed to determine the magnitude of refractive error. Information sheets describing the potential side effects were sent home to parents and teachers were given verbal information on the day of testing. Magnifying glasses and disposable sunglasses were offered to children if difficulty was reported in performing near school work.

3.2.6.1. Normative values of refractive error

Retinoscopy results were used to calculate the spherical equivalent refractive error (SER= sphere + cylinder/2). Table 3.3. describes how refractive error was defined (O'Donoghue *et al.,* 2010a). For purposes of statistical analysis, myopia, hyperopia and astigmatism were classified based on the eye with the better acuity.

Refractive error classification	Spherical equivalent refractive error (SER)
Myopia	≤ -0.50DS
Hyperopia	≥ +2.00DS
Astigmatism	≥ 1.00DC
Anisometropia	≥ 1.00DS
Aniso-astigmatism	≥ 1.00DC

Table 3.3 *Refractive error classification*

Data from a longitudinal and prospective study, the Northern Ireland Childhood Errors of Refraction (NICER) study (O'Donoghue *et al*., 2010b; McCullough *et al.,* 2014; Breslin *et al.,* 2013) were used to identify normative values for SER (Table 3.4).

	Spherical Equivalent refractive error (D)		
		Normative values	
Age group (yrs)	**Median**	**5th percentile**	**95th percentile**
6-7 (n=390)	+1.13	-0.13	+4.25
9-10 (n=295)	+0.75	-1.00	+4.38
12-13 (n=657)	+0.50	-1.63	+4.13
15-16 (n=427)	+0.50	-2.00	+3.88
18-19 (n=225)	+0.75	-3.00	+5.25

Table 3.4. *Normative values of SER from the NICER study*

3.3. Ocular health assessment

External ocular health was assessed using a direct ophthalmoscope. Indirect ophthalmoscopy using a 22D lens and/or direct ophthalmoscopy techniques were employed to examine internal ocular health in eight positions of gaze where possible (Elliott, 2013).

3.4. Conclusion

This chapter has described all the visual function and ocular health investigations employed in the feasibility study and SEE project.

Chapter 4 Feasibility of study protocol

This chapter describes a pilot study aimed to test the research protocol, recruitment strategies, recruitment response rates and instruments used for data collection.

4.1. Introduction

As stated in Chapter 1, it is extensively documented in the literature that children with SpEN are at a higher risk of visual problems compared to their typically developing peers (Das *et al*., 2010; Woodhouse *et al*., 2014; Pilling *et al.,* 2016; Gogate *et al*., 2011; Gogri *et al.,* 2016; Kaur *et al.,* 2016; Nielsen *et al.,* 2007, Muzaliha *et al.,* 2012). It is also widely recognised that clinicians examining this particular group of children need to be able to adapt their communication skills and optometric routine in order to achieve results that are both reliable and representative of the child's true status (Li *et al.,* 2015; McKillop, 2008; Bowman, 2016).

The author was experienced in primary care optometry prior to the commencement of the present study, but with limited exposure in the examination of children with SpEN. Therefore, a pilot study was conducted on a small group of children, to not only test the feasibility of methods and procedures but to facilitate training in specialist examination techniques.

4.1.1. Aims

To test the research protocol, recruitment strategies, recruitment response rates and instruments used for data collection.

4.2. Materials and Methods

4.2.1. Ethics

Approval for the study was obtained from Ulster University's Research Ethics Committee. The research adhered to the principles behind the declaration of Helsinki. Ethical implications are detailed in Appendix 1.

4.2.2. Recruitment

Roddensvale Special school is situated in Larne, County Antrim. In 2016 the school provided education for 92 children with severe to profound learning difficulties with an age range from 3 to 19 years old. Initial contact was made with the school via a telephone call and followed up a week later by hand delivery of information regarding the study to the Vice Principal. A week later the Vice-Principal confirmed via email the school's participation in the study. Information packs (Appendix 3.) were delivered to the school office and distributed to parents via the children's school bags.

4.2.3. Study personnel

The author carried out initial contact with the school and was present at all times during data collection. Additional support was provided by an associate investigator (ELM). Training in specialist techniques was delivered by the Chief Investigator (KJS) and project supervisors (JMcC and JAL).

4.2.4. Examination procedures

4.2.4.1. Baseline measures

Prior to the eye examination, written clinical history questionnaires (Appendix 4) were issued to parents/guardians in order to ascertain:

- The child’s ophthalmic history including where and when they had their last eye appointments, history of spectacle wear and any parental concerns.
- The child’s general health including notes on any medical conditions, medication and birth history.
- Family history of eye problems.
- Modifications made at home to account for any visual deficit.

In addition, teachers were issued with a written questionnaire (Appendix 4.) for each child which requested information regarding:

- The child’s spectacle wear in class
- Visual support provided by the school/ education authority
- Their own awareness of the child’s visual problems and any adaptions they made to the classroom or learning materials to account for any visual difficulties

After this time teachers put reminders for the parents in the child’s homework diary. All parents were invited to attend the eye examination which was conducted in the school’s medical room. The test procedures included:

- Monocular and binocular distance visual acuity
- Binocular near acuity
- Prism cover test
- Visual field
- Accommodative function
- Stereoacuity
- Contrast acuity
- Colour Vision
- Ocular health assessment

- Cycloplegic refraction

These test procedures are described in more detail in Chapter 3. In-school spectacle dispensing was offered where necessary at no cost to the parent.

Permission was also sought from parents to view each child's SEN/ECHP to gain information on each child's diagnosis/ level of learning difficulty.

4.2.4.2. Written report

A written 6-page report (Appendix 5) was issued to parents and teachers following the baseline examination. The report described the child's visual strengths and limitations in a format understandable to non-eyecare professionals and consisted of nine sections.

- *Section 1*- Details of the child including name and date of birth
- *Section 2*- Date the eye examination occurred
- *Section 3*- Additional detail about the eye examination, i.e. who was present and any parental/teacher concerns.
- *Section 4*- Assessor details.
- *Section 5*- Summary of findings from the eye examination including actions and recommendations from the eye examination i.e. The need for glasses or modifications required to the classroom or learning materials to account for visual need. This also included advice on whether the SEN should include visual information.
- *Section 6*- Advice regarding glasses wear
- *Section 7*- Results of vision tests
- *Section 8*- Results of ocular health check
- *Section 9*- Technical details for other health professionals

4.2.4.3. Follow-up measures

Follow-up measures were performed on participants between two to three months later. Repeated measures included: presenting visual acuity at distance and near, accommodative function, non-cycloplegic refraction and an ocular health check. Where a participant had been prescribed a new/updated prescription and presented wearing them to the follow-up assessment, measurements of stereoacuity and low contrast acuity were repeated.

4.2.4.4. Follow-up questionnaires

Written feedback questionnaires were issued to parents and teachers (Appendix 4.) after the follow-up measures were completed. These questionnaires were used to gain parent/teacher feedback on their experience of the in-school eye examinations. The feedback questionnaires were also used to determine whether parent and/or teacher appreciation of the participants' visual status had altered and whether actions recommended in the written report, designed to address visual needs, had been implemented i.e. whether spectacles were worn, learning material adapted, environmental modifications made.

4.2.4.5. Data entry, analysis and statistics

Initial data entry were carried out using Microsoft Excel. The data was anonymised using an individual code for each participant. A separate password protected file was created to store the name of participants, together with their unique identity code. The data was then transferred into the statistical package SPSS v.25.

4.3. Results

The purpose of this study was to test research protocol, recruitment strategies, response rates and instruments used for data collection, therefore no formal analysis of the data is presented here.

4.3.1. Response rates

Consent was obtained for 29 of the 92 pupils enrolled at Roddensvale school between February 2016 and June 2016 representing a consent rate of 32.0%. Baseline questionnaires were returned by 86.2% of parents (25/29) and by 75.9% (22/29) of teachers. Post-eye examination feedback questionnaires were returned by 51.7% (15/29) of parents and 12.5% (2/16) teachers.

4.3.2. Participant profile

4.3.2.1. Gender

Twenty (69.0%) participants were male and nine (31.0%) were female.

4.3.2.2. Age

Participant age ranged from 5 to 18 years old with a mean of 10.90 ±4.90 years old.

4.3.2.3. Diagnosis and learning difficulty

Statements of educational need (SEN) were available for 93.1% (27/29) of participants. Details of diagnoses and level of learning difficulty were extracted from participants' SEN and is summarised in Table 4.

Diagnosis / Learning Difficulty	Autism	Epilepsy	Cerebral Palsy	Speech and Language difficulties	Social and emotional developmental delay	Hearing impairment	Down syndrome
Profound	0	1	0	1	0	1	0
Severe	8	5	3	15	0	1	0
Moderate/ Severe	1	0	0	1	2	0	0
Significant	1	0	1	1	0	0	0
No level recorded	3	0	1	3	0	0	0

Table 4. *Level of learning difficulty* and *diagnoses of participants. N.B. participants may be included in more than one category.*

4.3.3. Success rates

Table 4.1. illustrates the success rates of measures at baseline and follow-up.

Measure	Baseline success rate (n=29)	Follow-up success rate (n=27)
Distance visual acuity	**97.0%**	**96.2%**
Near visual acuity	**55.2%**	**44.4%**
Prism cover test	**93.1%**	
Visual field	**89.7%**	
Accommodative Function	**89.7%**	**81.5%**
Stereoacuity	**85.7%**	
Contrast Acuity	**51.7%**	
Colour vision	**51.7%**	
Ocular health assessment	**79.3%**	**92.6%**
Cycloplegic refraction	**86.2%**	

Table 4.1. *Success rates of measures at baseline and follow-up*

4.3.4. Feedback Questionnaires

4.3.4.1. Parental feedback

Fifteen parents (51.7%) returned feedback questionnaires and their responses are summarised below.

Usefulness of the in-school eye test for the parent and their child to have an in-school eye test.

The in-school eye examination was reported by parents to be "very useful" or "useful" for

i) Themselves (93.3%, n=14)

ii) Their child (73.3%, n=11)

Advantages/disadvantages of in-school eye tests rather than at the hospital or local opticians

Thirteen parents (86.7%) reported it that it was advantageous having eye examinations delivered in school. Reasons given included:

- Familiar environment
- Friends and staff nearby to offer support
- Saves parents having to travel to hospitals
- It helps seeing others getting their test done
- Waiting times can be very long at clinics
- It provides reassurance that previous eye tests are accurate especially as its difficult for children with severe learning difficulties to express themselves or answer questions accurately

Did the report provide any information that was previously unknown to the parent?

Five (33.3%) parents stated that the written report provided new information regarding their child's visual status. Three parents commented on the new information being details on visual field defect, reduced 3D vision and abnormal contrast sensitivity

Was there information contained on the report easy to understand and useful to parents on a day to day basis?

91.7% of parents said that the report was "easy"/ "fairly easy" to understand and 66.7% found the information contained on the report to be useful on a day to day basis. 16.7% of parents have instigated adaptions to the child's home environment where modifications were recommended in the report.

The most helpful and least helpful parts of the report

Parents stated that there were no least helpful parts of the report. Helpful parts of the report were recorded as:

- Giving a precise outline and correct terminology for daughter's eyesight
- Confirmation on the restrictions in fields of vision and implications for son's awareness of obstructions, hazards, difficulties.
- Recommendations that school tasks should be presented in a simple format without too much information at one time
- It provides a better understanding having information written on paper

4.3.4.2. Teacher feedback

Two teachers completed the teacher feedback questionnaires. Both teachers felt that in-school eye tests were beneficial for pupils. Both teachers agreed that it was advantageous for pupils to have their eye test carried out in school with one stating "they are used to the school environment already" and the other "it can sometimes be easier for some pupils to [have their eyes tested in school] as they could refuse for parents."

Teachers identified difficulties in having enough staff to go with pupils to the in-school eye test during staff breaks/ toileting etc. and felt that taking pupils out of class could, at times, disrupt group activities.

One teacher found the report useful and found the most helpful part of the report to be the identification of tasks that could be difficult for pupils and the strategies provided to help.

4.4. Discussion

4.4.1. Recruitment

The current study had a participation rate of 32% which is similar to the 31.0% reported by Woodhouse *et al.* (2013). Donaldson *et al.* (2019) reported higher participation rates of 66-92% however this is illustrative of a service established in England over a four-year period. This pilot study demonstrates that additional recruitment strategies are required to generate a more representative sample of the children attending special schools in Northern Ireland.

Walsh *et al.* (2016) identified communication of participant information in an easy to understand format and good investigator/participant relationship to be key factors in improving participation. The review also reports that information delivered in a newsletter format provides participants with more confidence in the research being undertaken.

Therefore, ***to improve recruitment*** the author determined to:

- establish good communication links with both teachers and parents through face to face meetings at the commencement of the study.
- create a website that includes information about the project and introduces study investigators in an appealing, easy read format.

4.4.2. Research protocol

4.4.2.1. Success rates of visual measures

Table 4.2. details the success rates of visual measures performed on other cohorts of children with SpEN in the UK together with results from the present study.

Similar rates of success were reported by (Woodhouse *et al.,* 2014) for measurements of visual acuity and ocular alignment. The present study reported a lower success rate in refractive error measurement compared to Woodhouse *et al.* (2014), and Donaldson *et al.* (2019). However, both studies only utilised cycloplegia to determine refractive error in a minority of participants (9.2% and 5% respectively) in contrast to 86.2% of participants in this study. Whilst these studies have higher success rates for measuring refractive error their results may be less meaningful as non-cycloplegia refraction has been shown to overestimate myopia and underestimate significant hyperopia (Fotedar *et al*., 2007; Morgan *et al.*, 2015). A successful measure of refractive error was achieved on a further three participants at follow-up in the present study, therefore boosting the refractive error success rate to 96.5% which is similar to Das *et al.,* (2010) and Pilling *et al.,* (2017) who both used cycloplegia. The success rate of ocular health assessment compares favourably with Das *et al.,* (2010), as does the success rate of accommodation assessment with Donaldson *et al*. (2019).

Visual measure	**Das et al., 2010. (n=240)**	**Woodhouse et al., 2014 (n=173)**	**Pilling et al., 2017 (n=100)**	**Donaldson et al., 2019 (n=949)**	**Feasibility study (n=29)**
Visual acuity	79.2% (190/240)	96.0% (166/173)	62.0% (62/100)	60.5% (574/949)	97.0% (28/29) *Distance* 55.2% (15/29) *Near*
Refractive error	95.0% (228/240)	100% (173/173)	93.0% (93/100)	98.2% (932/949)	86.2% (25/29)
Ocular health assessment	96.3% (231/240)				93.1% (27/29)
Accommodation		93.1% (161/173)		73.8% (700/949)	79.3% (23/29)
Ocular alignment		99.4% (172/173)			93.1% (27/29)

Table 4.2. *Success rates of visual measures conducted in the present study and in other parts of the UK.*

The success rate for the measurement of low contrast acuity was low (51.7%) however this is not surprising as a high contrast logMAR acuity measure was possible in only 58.6% of participants at baseline. A higher success rate (>70%) was reported in children with Down syndrome by measuring contrast sensitivity using the Cardiff contrast sensitivity preferential looking test (John *et al.,* 2004).

It was noted that success rates for all visual measures increased when the staff member accompanying the participant was actively engaged in the eye examination. This was particularly evident in the examination of non-verbal children when classroom assistants explained test procedures using Makaton, a simple form of sign language.

In view of these pilot data, the study protocol was refined to remove the measurement of low contrast acuity and replace with a measurement of contrast sensitivity using the Cardiff contrast sensitivity test. In addition, the investigators completed training in basic Makaton, in order to better communicate with non-verbal children.

4.4.2.2. Return rates of questionnaires

The returns rates of questionnaires decreased from 86.2% to 51.7% for parents and 75.9% to 12.5% for teachers following baseline and follow-up examination. It is the author's opinion that this is likely to be a result of time constraints imposed on the study and as a result, feedback questionnaires were issued to parents and teachers after the two-month summer holiday.

4.4.2.3. Eye examination schedule

The children attending Roddensvale started school at 9.30am, younger children were picked up at 1.30pm and older children at 2.45pm. Initially investigators aimed to examine a minimum of four children per day, however this was not always possible. Challenges arose from children being absent due to illness or being out swimming or on school trips. Staff resourcing often presented as a challenge; it was not always possible for teachers to release a member of staff to accompany the child to the eye examination. The author had no access to class timetables or the school calendar making it difficult to plan an eye examination schedule. In a larger study, access to this information could prove invaluable in minimising classroom disruption.

Therefore, ***to minimise disruption*** the author determined to gain access to class timetables, school calendar and staff break times when planning participant baseline and follow-up assessments.

4.4.2.4. Written report and intervention

Only 16.7% of parents who were given advice in the written report on home modifications reported implementation. One of the reasons for this may be the design of the written report. The first page contained details of the child, parental concerns and assessor information whilst the information-rich summary was hidden on the second page. Tang *et al.* (1998) reported that patients preferred information regarding their health to be clear and concise. The author therefore determined to condense the report and move the summary to the front page to avoid important information being lost.

Data were available at follow-up for three of the four participants who presented without glasses and were given a new or updated prescription at the baseline examination. Only one was compliant with spectacle wear at follow-up. No information was available to determine the reason for poor spectacle wear within this small sample, however, key reasons reported in the literature include the loss or breakage of spectacles, uncomfortable frames, don't feel spectacles are needed, parents disapprove of spectacles (Messer *et al*., 2012; Holguin *et al*., 2006; Gogate *et al.,* 2013) and negative comments from others (Horwood, 1998). Spectacle compliance was shown to improve in schools in New York when teachers were advised of the classroom activities for which the child required glasses alongside the provision of additional pairs of spectacles to teachers to keep in the classroom in the event that the child presented to class without their spectacles (Ethan *et al*., 2010).

Therefore, ***to improve the success rate of intervention,*** the author determined to,

- provide a spare pair of spectacles to be kept in-school with the teacher where poor compliance has been identified at baseline.
- encourage teachers and parents to make positive comments to the participants who are given new glasses.
- source light, flexible and comfortable frames.

- condense the current six-page report into four pages and ensure that the summary and action section are clearly displayed on the front page.

4.5. Conclusion

The pilot study identified several areas of the protocol and support material that required refinement prior to the main study; including enhancement of the recruitment strategy, testing protocol and reporting documentation.

Chapter 5 Methods

This chapter describes the methods employed in the SEE project and details participant characteristics and success rates.

5.1. Introduction

Study protocol was refined following recommendations from the Feasibility study described in Chapter 4. This chapter describes the methods employed in the SEE project.

5.2. Materials and Methods

5.2.1. Ethics

Approval for the study was obtained from Ulster University's Research Ethics Committee. The research adhered to the principles behind the declaration of Helsinki. Ethical implications are detailed in Appendix 1.

5.2.2. Methodology design

A quasi-experimental mixed methods design was adopted to evaluate the outcomes of intervention. Although randomised control trials are considered to be a more robust approach (Hariton & Locascio, 2018) it was not deemed to be appropriate for this population due to practical and ethical constraints. Nevertheless, the quasi-experimental design is recognised as being useful in testing interventions for their effectiveness in 'real-world' settings and can therefore inform evidenced-based practice (Handley *et al.,* 2018).

5.2.3. Sample identification and sample size

Results from "The Special School Survey" described in Chapter 2 identified schools where no current in-school eyecare was available. Castle Tower school in Ballymena, Co.

Antrim was approached to participate in the study as the largest special school in Northern Ireland.

Sample size calculations were performed using data from previous studies (Das *et al.,* 2010)

Das *et al.* (2010) report that 24% of their sample of 228 children in a special education setting presented with uncorrected, or sub-optimally corrected, refractive error (as determined by cycloplegic retinoscopy and needing new/updated Rx). To determine a reduction of 50% or more in this metric, with a statistical power of 95%, required a sample size of 106 (Figure 5).

One-sided to detect reduction in uncorrected refractive error with 95% power.

z_β and $z_\propto$ = 1.6449; π_0 = 0.24; π_1= 0.12 and d is the difference between the two proportions.

$$n = \frac{1}{d^2}\left(z_\propto\left(\sqrt{\pi_0(1-\pi_0)}\right) + z_\beta\left(\sqrt{\pi_1(1-\pi_1)}\right)\right)^2$$

$$n = \frac{1}{0.12^2}\left(1.6449\left(\sqrt{0.24\ (0.76)}\right) + 1.6449\left(\sqrt{0.12(0.88)}\right)\right)^2$$

n = 106

Figure 5. *Sample size calculation*

The sample size was inflated to 200 to allow for a 50% dropout rate at follow-up (Plachta-Danielzik *et al.,* 2007; Gillum *et al.,* 1981).

5.2.4. Recruitment

Initial contact was made to the school via a telephone call and then followed up a week later via an email with information regarding the study. Arrangements were then made to visit the Principal at the school to answer any questions and to identify a suitable time in the school calendar for data collection. A Steering group was established consisting of the project investigators, invited parents and teachers and the Principal. A meeting was held in Castle Tower School on 25th May 2016 to discuss ways to optimise recruitment and minimise disruption to the school day throughout the project duration.

Outcomes from this meeting included:

- The allocation of a stall at the school's Summer Fayre dedicated for the use of the SEE project research team. This gave a platform for the investigators to have face-to face contact with parents to discuss the project.
- An announcement was delivered to parents via the Castle Tower School App informing them that the SEE project would be proceeding in the school.
- Pupil annual reviews were identified as a good point of contact with parents. Teachers were therefore given information packs to hand out to any parent that showed interest in their child taking part in the project.
- Two teachers were appointed by the principal to be Teacher Project Coordinators. Their role was to be a point of contact for the investigators, distribute information packs to teachers, ensure a suitable room was available to perform eye examinations and provide class timetables.

Teachers distributed information packs to parents via the children's school bags and at pupil annual reviews. The packs included a parent information sheet outlining the testing procedures and rationale behind the study, a child friendly version of this information in the form of a poem and a parental consent form (Appendix 3.). Consent forms were returned to the Teacher Project Coordinators in the envelope provided.

5.2.5. Study personnel

The author, a qualified optometrist, made the initial contact with the school and was involved in the examination of all the participants at either baseline assessment, follow-up assessment or both. Additional support was provided by associate investigators ([2]ELM) and ([3]RL), both qualified optometrists.

The author completed a Makaton foundation course prior to testing in order to better communicate with non-verbal children.

5.2.6. Examination procedures

5.2.6.1. Baseline questionnaires

Prior to the eye examination, written clinical history questionnaires described in chapter 4 were issued to parents/guardians (Appendix 4).

A call log was created to record any contact made with parents. Parents were asked to return questionnaires two weeks after receiving them. After this time parents were sent reminders via their preferred method of contact i.e. phone call, text message or email. The Teacher Project Coordinators managed teacher questionnaire returns and followed up on any that were outstanding.

Participants' Statements of Educational Need (SEN) were examined for information regarding participant visual status, including any visual limitations and/or recommended modifications to the classroom or learning materials.

5.2.6.2. Baseline eye examination

All parents were invited to attend the in-school eye examination. The eye examination was carried out in a suitably sized room (>3metres in length) which could be darkened and included the following test procedures.

- ***Visual acuity***: Binocular and monocular assessment of visual acuity was attempted on all participants without spectacles and with spectacles where applicable. An appropriate acuity test was chosen based on the participant's age and ability.
- ***Contrast sensitivity***: Measured binocularly using the Cardiff contrast test at 50cm with spectacles on if worn.
- ***Prism cover test:*** Measured at distance and near
- ***Eye movement and control assessment:*** Ocular motility, pursuits, saccades and NPC.
- ***Visual field assessment:*** Assessed using the confrontation method.
- ***Accommodative function:*** Measured using the Ulster-Cardiff accommodation cube with spectacles on if worn.
- ***Stereoacuity:*** Measured using the Frisby Stereo Test.
- ***Colour vision:*** Assessed using the CVTME.
- ***Cycloplegic refraction:*** Measured using retinoscopy following the insertion of Cyclopentolate Hydrochloride 1% in each eye.
- ***Ocular Health Assessment:*** Using direct/indirect ophthalmoscopy.

5.2.6.3. In-school spectacle dispensing

In-school spectacle dispensing was offered in instances where a participant required a new or updated spectacle prescription or had a frame that needed replaced. Through the research project's funds, spectacles were supplied at no cost to parents. Parents were involved in the choice of the frame, alternatively parents could take the spectacle prescription to their local optometrist to be filled at their own cost.

5.2.6.4. Written report

The updated 4-page semi-standardised version of the written report was issued to parents and teachers following the baseline eye examination (Appendix 5.). The report described each participant's visual strengths and limitations in a format accessible for non-eye care professionals

5.2.6.5. Follow-up eye examination

Two to five months after the baseline eye examination the children were reviewed, and the following measures were repeated: presenting visual acuity at distance and near if possible (using the same test applied at the baseline eye examination), presenting ocular alignment, eye movement and control, accommodative function, non-cycloplegic retinoscopy, ocular health assessment and contrast sensitivity (it was noted if spectacles were prescribed and worn at the review).

5.2.6.6. Follow-up questionnaires

Written feedback questionnaires were issued to parents and teachers (Appendix 6) after the follow-up eye examination. These questionnaires were used to determine whether parent and/or teacher appreciation of the participants' visual status had altered and whether actions recommended in the written report, designed to address visual needs, had been implemented i.e. whether spectacles were worn, learning material adapted, environmental modifications made.

To ensure maximal return rates of the questionnaires, reminders were issued to parents over the phone, via text message or via email. The Teacher Project Coordinators sent internal email reminders to teachers to prompt the return or feedback questionnaires.

SEN/ECHPs were reviewed one year after initial assessment to ascertain if any amendments recommended in the written report had been made.

5.2.6.7. Participant journey

Figure 5.1. illustrates the participant's journey within the SEE project.

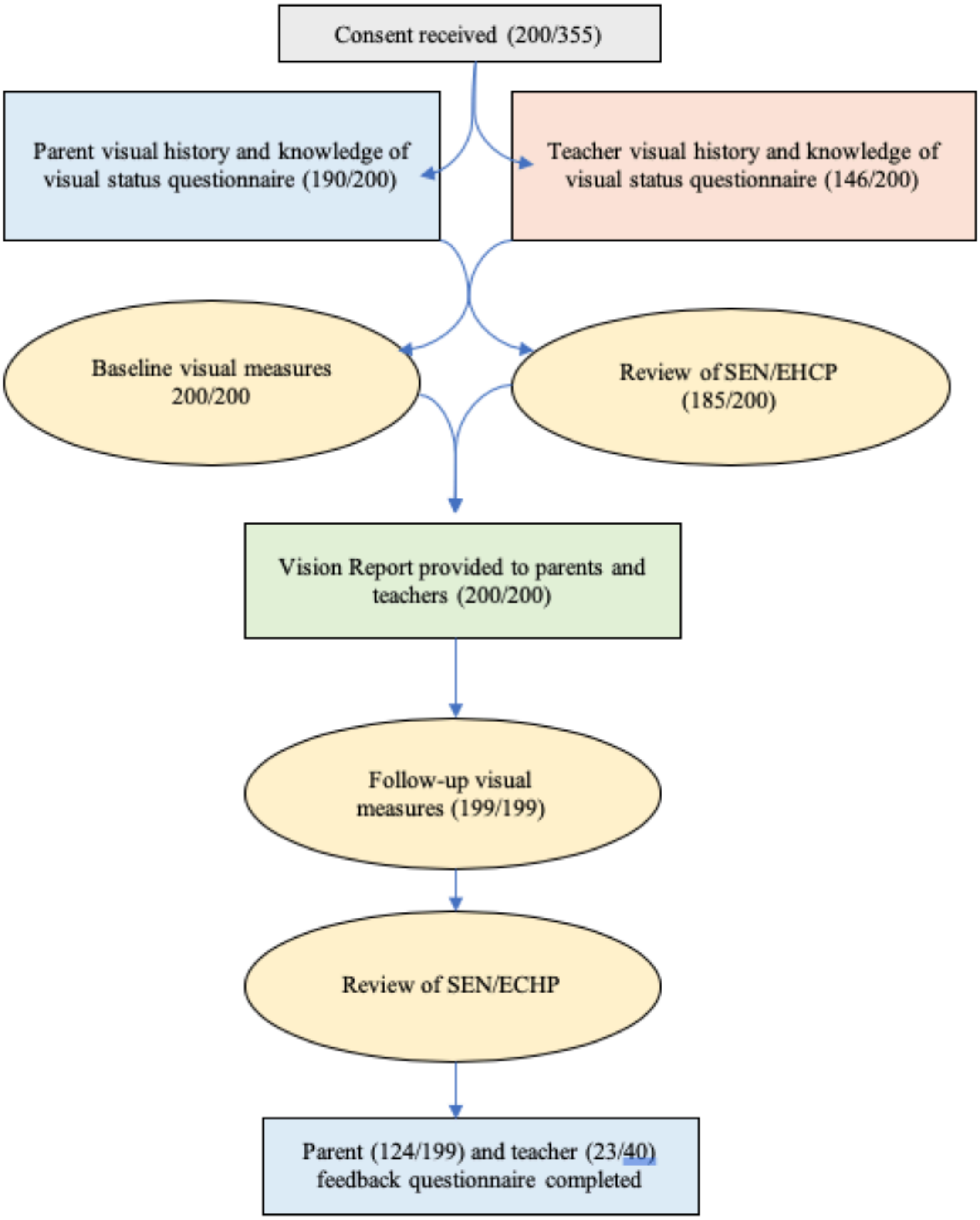


Figure 5.1. *Participant's SEE project journey.*

5.2.7. Definitions

5.2.7.1. Visual and ocular deficits

Visual deficits were defined as a visual problem which may prevent the child from accessing learning materials, reduce mobility or inhibit communication/social interaction with those around them. An ocular deficit is defined as any pathology or anomaly in the eye. Six visual/ocular deficit domains were identified and are defined in Table 5.

Visual/Ocular Deficit	Definition
Refractive issues: Significant refractive error[1]/ accommodative deficit[2]	Isometropia Myopia ≤-2.50D Hyperopia ≥+3.50D (no manifest deviation) Hyperopia ≥+1.50D (with esotropia) Astigmatism ≥1.50DC Anisometropia Myopia < -2.50D Hyperopia ≥+1.50D Astigmatism ≥1.50DC Hypo-accommodation (lag)<2.94D
Reduced contrast sensitivity[3]	<33.3 (3-4 yrs old) <50 (4yrd old or beyond)
Reduced distance[4,5] and/or near[5] acuity	Poorer than 0.3logMAR (either binocular or in the better eye) at distance 0.4logMAR or poorer (binocular) at near
Ocular pathology[6]	Ocular anomaly or disease
Visual field defect[7]	Constricted or partially restricted peripheral vision
Anomalous eye movement or control[8,9]	Manifest strabismus Poor tracking ability NPC≥10cm Restriction in ocular movement

Table 5. *Visual/ocular defict definitions. 1=Wallace et al., 2018, 2=McClelland et al., 2004, 3=Barbareza et al., 2008, 4=World health Organisation, 2018, 5=Cumberland et*

al., 2016, 6=Larson et al., 2015, 7=Cummings et al., 1988, 8=Adler et al., 2002 9= (Gilligan et al., 1981).

Refractive error was considered using a criterion where the lack of refractive correction would mean a significant detriment to visual function instead of criterion typically used to describe prevalence. Accordingly, the conservative American Academy of Ophthalmology (AAO) guidelines for refractive correction of children over three years of age was used to define significant refractive error for the least ametropic eye (Table 5). These criteria were used to describe and update spectacles at baseline however a more clinical approach was taken at follow-up to address lower levels of refractive error.

Reduced distance acuity was defined using Cumberland *et al.* (2016) definition of socially significant visual impairment, i.e. >0.3logMAR (either binocular or in the better eye). Reduced near acuity was defined using the World Health Organisation (2018) definition of visual impairment at near, i.e. 0.4logMAR or poorer (binocular).

The remaining visual deficits were defined using normative data detailed in Chapter 3.

5.2.7.2. Unmet need

The questionnaires issued to parents and teachers at baseline were used to identify whether visual/ocular deficits detected at the baseline eye examination were previously known about and addressed by parents and teachers. An '**unmet visual need'** was identified in instances where a visual/ocular deficit was unknown and not addressed by the participants' parent or teacher. In an attempt to meet these needs, actions were taken as appropriate to rectify visual/ocular deficits (e.g. dispensing of spectacles), recommendations for environmental modifications (e.g. high contrast learning materials) and referral to specialist services (e.g. referral to ophthalmology) were included in the written report.

Table 5.1. describes the actions required and/or strategies to be implemented to meet each visual/ocular deficit if identified as being an unmet need.

Visual/ocular deficit	**Actions to address unmet needs**
Refractive issues (Refractive error and or hypo-accommodation)	• Parent / teacher informed • First time spectacles issued • Updated prescription issued if current spectacles not appropriate • Advice on encouraging compliance if spectacles not worn
Reduced contrast sensitivity	• Parent / teacher informed • Modifications made at home/school
Reduced acuity at distance and/or near	• Parent / teacher informed • Environment modifications made at home/school
Ocular deficit	• Parent informed • Onward referral if necessary
Visual field deficit	• Parent/teacher informed • Modifications made at home/school
Anomalous eye movement and control (including strabismus)	• Parent advised through report • Treatment given • Onward referral if necessary • Modifications made at home/school

Table 5.1. *Actions/strategies required to meet unmet visual needs.*

5.2.8. Data entry, analysis and statistics

Initial entry was carried out using Microsoft Excel. The data were anonymised using an individual code for each participant. A separate password-protected file was created to store the name of participants, together with their unique identity code. The data were then transferred into the statistical package (SPSS v.25). Error checking and cleaning was carried out by SAB and ELM prior to analysis.

5.3. Results

5.3.1. Response rates

Consent was obtained for 200 of the 335 pupils enrolled in the school between September 2016 and June 2018 representing a 59.7% consent rate. Of those 200 participants:

- Seven (3.5%) parents declined access to SEN
- Two (1%) parents declined to complete questionnaires
- Six (3%) parents did not give permission for their children to have cyclopentolate hydrochloride 1% drops instilled.

Baseline parent questionnaires were returned for 85.9% (170/198) of participants and baseline teacher questionnaires were completed for 73.0% (146/200) of participants.

Post-eye examination feedback questionnaires were returned by 62.9% (124/197) of parents. Twenty-three (57.5%) of the forty teachers invited to complete a feedback questionnaire complied.

5.3.2. Participants

5.3.2.1. Gender

Sixty (30%) of the participants were female and 140 (70%) were male.

5.3.2.2. Age

The age of the participants ranged from 3.58 to 19.75 years old with a mean of 10.73 (±4.01) years old.

5.3.2.3. Learning difficulty

Permission was obtained from 193 of parents to view their child's statement of educational need (SEN), however six statements were inaccessible to the investigators throughout the duration of the project. 185 statements were examined to ascertain the children's level of learning difficulty. Six (3.2%) did not have any information about level of learning difficulty recorded on their SEN. Table 5.2. describes the level of learning difficulty and the age distribution of participants.

Level of learning difficulty (LD)	n (%)	Mean age years ±SD	Range
Complex	1 (0.54%)	6.42	-
Profound	2 (1.1%)	7.29 ±2.77	5.33-9.25
Severe (SLD)	69 (37.3%)	10.94 ±4.91	3.92-19.75
Moderate/severe (MLD/SLD)	27 (14.6%)	9.67 ±4.05	4.33-18.58
Moderate (MLD)	80 (53.2%)	11.22 ±3.19	3.75-17.67
Delayed	1 (0.54%)	11.38	-
Mild/Moderate (Mild/MLD)	1 (0.54%)	12.42	-

Table 5.2. *Level of learning difficulty of participants*

5.3.2.4. Underlying diagnosis

SENs (n=185) were examined for details regarding participants' medical conditions/ diagnoses. Table 5.3. describes the diagnoses of participants and corresponding mean age.

Diagnosis	N (%)	Mean age years ±SD	Range
Autism	61 (33%)	9.61 ±3.84	3.92-17.75
Cerebral Palsy	5 (2.7%)	9.47 ±3.22	4.92-13.92
Down syndrome	18 (9.7%)	11.05 ±5.24	4.33-19.75
Epilepsy	11 (5.9%)	11.17 ±3.41	5.42-17.67
Speech and Language problems	123 (66.5%)	10.17 ±4.03	3.75-19.75
Hearing impairment	5 (2.7%)	7.55 ±1.78	5.58-9.83
Other medical conditions/ syndromes	37 (20%)	9.98 ±3.90	4.17-18.58

Table 5.3. *Diagnosis distribution of participants (N.B. participants may have more than one diagnosis)*

5.3.2.5. Parent report of previous eyecare

Information regarding previous eyecare history was available for 190 (95%) participants (170 completed parent questionnaires, 20 from via telephone). One hundred and sixty-seven (87.9%) reported a history of eyecare, 21 (11.1%) parents reported no previous eyecare for their child and 2 parents (1.1%) didn't know if the participant had a previous history of eyecare.

Of the 167 who had a previous history of eyecare, 87 (52.1%) had been prescribed spectacles. Parents of the children who had been prescribed spectacles report that 9.3% (n=8) rarely and 19.8% (n=17) do not comply with spectacle wear.

5.3.3. Representation of participants vs population

Table 5.4. describes the gender, age and learning difficulty distribution of participants compared to the pupil profile of Castle Tower and also to the special school population in Northern Ireland.

		SEE Project	Castle Tower	Is the study sample representative of Castle Tower school?	All special schools in NI (Department of Education, 2018)	Is the study sample representative of Special school population in NI?
Gender	**Male**	140 (70.0%)	224 (73.2%)	**Yes** (χ^2=0.580, p=0.446)	4045 (70.5%)	**Yes** (χ^2=0.026, p=0.871)
	Female	60 (30.0%)	82 (26.8%)		1690 (29.5%)	
Age (yrs)	**Mean (SD)**	10.73 (±4.01)	11.54 (±4.10)	**No** (Mann-Whitney U= 28145, p=0.015)	10.07 (±4.29)	**Yes** (Mann-Whitney U=527035, p=0.051)
Learning difficulty	**SLD**	70 (35.0%)	104 (34.1%)	**Yes** (χ^2=0.560, p=0.454)	1749 (30.5%)	**No** (χ^2=0.031, p=4.678)
	MLD	80 (40.0%)	141 (46.2%)		1312 (22.9%)	

Table 5.4 *Gender, age and learning difficulty distribution of participants*

The SEE project sample was representative of the pupil profile of Castle Tower school in terms of gender and level of learning disability and representative of Northern Ireland's special school population in terms of age and gender.

5.3.4. Success rates

Table 5.5. details the success rates achieved when assessing each of the visual functions and aspects of ocular health.

Test		*Method*	*Success rate % (n)200*
Vision	Distance	**Formal measurement of vision successfully achieved**	**98.5% (n=197)***
		Sonsken crowded logMAR letters at 3m	n=120
		Sonsken logMAR single letters at 3m	n=1
		LEA crowded logMAR symbols at 3m	n=27
		LEA logMAR single symbols at 3m	n=3
		Cardiff acuity test	n=47
	Near	**Formal measurement of vision successfully achieved**	**70.5% (n=141)**
		Sonsken crowded logMAR letters at 40cm	n=116
		LEA crowded logMAR symbols at 40cm	n=25
Ocular alignment	Distance	Prism cover test (3m)	99% (n=198)
	Near	Prism cover test (40cm)	100% (n=200)
Ocular movements		Pursuit and saccadic eye movement quality to penlight at 40cm	84% (n=168)- pursuits 88.5% (n=177)- saccades
		Ocular movements in eight directions of gaze	84% (n=168)
		Near point of convergence to target, until break noted or diplopia reported	88.5% (n=177)
Accommodative function		Dynamic retinoscopy (Ulster-Cardiff accommodation CUBE with target at 24cm/4D)	97% (n=194)
Contrast sensitivity		Cardiff Contrast Test	91.5% (n=183)
Visual Field		Binocular gross confrontation to a 15cm white ball	93.5% (n=187)
Refractive error		**All methods**	**98.5% (n=197)**
		Cycloplegic retinoscopy (1% cyclopentolate HCl)	n=181
		Non-cycloplegic distance static retinoscopy	n=16
Ocular health		**All methods**	**99.5% (n=199)**
		Dilated direct/indirect ophthalmoscopy	n=181
		Un-dilated direct/indirect ophthalmoscopy	n=16

Table 5.5. *Success rates of visual function assessments and ocular health investigations.*

5.4. Discussion

The participation rate of the current study (59.7%) is almost twice the 31% uptake recorded in the Welsh study (Woodhouse *et al.,* 2014) and the 32% participation rate in the pilot study described in Chapter 4. The retention rate of 99.5% was significantly higher than anticipated from initial power calculations. It is the author's opinion that the reason for the study's high participation and retention rate was the result of a series of engagements with parents and teachers prior to recruitment taking place and throughout the study, based on the experience of the feasibility study.

The use of text messaging to remind participants to complete paper based questionnaires has been shown to be effective by Kew *et al*. (2010). This was reflected in the current study by the high percentage return of baseline questionnaires from parents (85.9%) and teachers (73.0%). At follow-up return rates of questionnaires from both parents and teachers decreased. This may be due parent and teacher fatigue with the extended nature of the project and the need to complete multiple questionnaires.

The success rates of measures improved for all measures (Table 5.6.) It is the author's opinion that the increase in success is the result of the experience gained by the author in the feasibility study and an improvement in communication skills following the undertaking of a Makaton course.

Visual measure	**The SEE project (n=200)**	**Feasibility study (n=29)**
Visual acuity	98.5% Distance 70.5% Near	97.0% Distance 55.2% Near
Refractive error	98.5%	86.2%
Ocular health assessment	99.5%	93.1%
Accommodation	97%	79.3%
Ocular alignment	100%	93.1%

Table 5.6. *Success rates, SEE project vs Feasibility study*

5.5. Conclusion

This chapter has described the methods employed in the SEE project. The sample has been shown to be representative of the special education population in Northern Ireland. High participation, questionnaire return and success rates have been attributed to the experience of investigators and strong communication links between parents, teachers and investigators.

Chapter 6 Visual profile of children attending a Special school in Northern Ireland

This chapter describes the participants and the visual status of children attending a special school in Northern Ireland in relation to normative data.

6.1. Introduction

There are differences in the type and scope of eyecare services offered to children in different regions of the UK and these differences may influence the visual outcomes and profiles found in each region. Previous UK studies (Donaldson *et al.,* 2019; Woodhouse *et al.,* 2014; Das *et al.,* 2010) have described the ocular status of children attending special schools in England, Scotland and Wales however the visual status of children attending special schools in Northern Ireland is yet to be examined.

6.1.1. Aims

This study aims to investigate the influence of the children's characteristics on ocular status.

6.1.2. Objectives

i) Describe the visual profile of a SpEN population in Northern Ireland
ii) Examine the relationship between published normative data relating to ocular status and the age, gender, education level, severity of learning difficulty and diagnosis of participants.

6.2. Methods

All children participating in the project underwent a full eye examination as detailed in Chapter 5 to determine visual status. Parent and teacher questionnaires (Appendix 4.)

were used in conjunction with the examination of Statements of Educational Need (SEN) to establish each child's;

i) Age

ii) Gender

iii) Education level i.e. Primary or post-primary

iv) Level of learning difficulty e.g. severe, moderate etc.

v) Diagnoses

Visual measures were compared to normative values detailed in Chapter 3. Non-parametric tests i.e. Mann-Whitney U, Kruskal Wallis and Chi-squared tests were employed to investigate the influence of participants' characteristics on visual measures.

6.3. Results

6.3.1. Refractive error

A measure of refractive error was successfully obtained from 197 (98.5%) participants. One-hundred and eighty (91.4%) underwent a cycloplegic refraction, eight (4.1%) refused eye drops, six (3.0%) parents refused consent for eye drops, and three (1.5%) were uncooperative with instillation of eye drops. Table 6. shows the distribution of refractive errors.

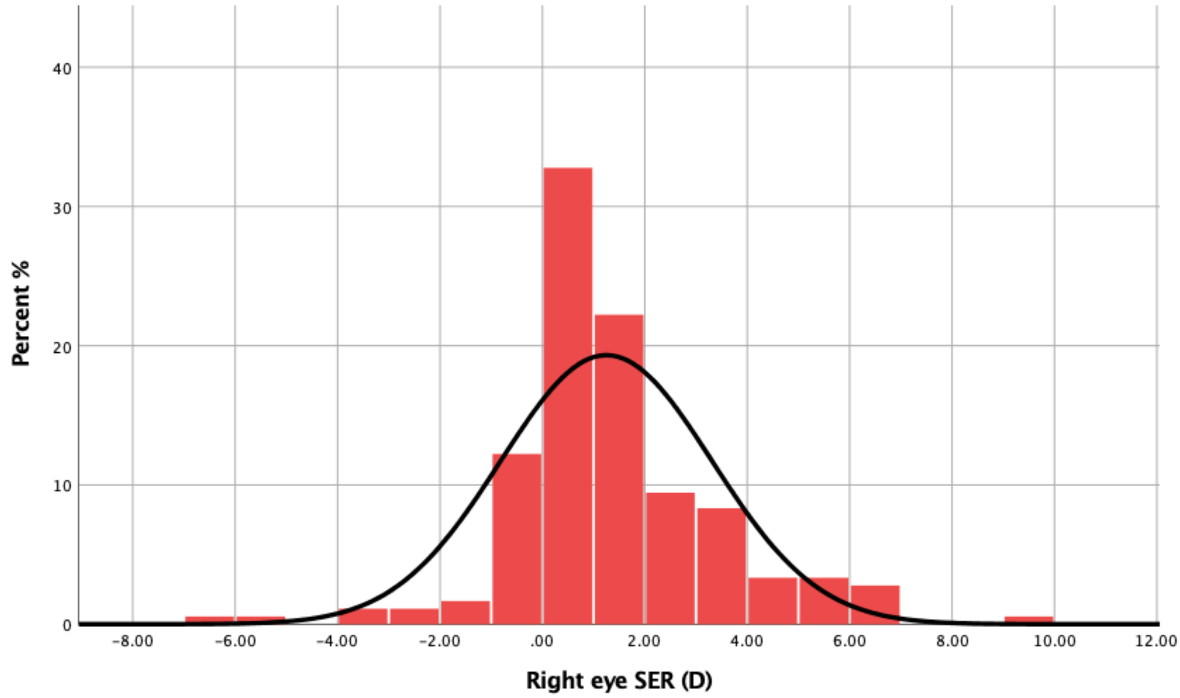
Refractive error	All (n=197)	Cycloplegic refraction only (n=180)
Myopia ≤0.50DS	26 (13.2%)	19 (10.6%)
Hyperopia ≥+2.00DS	45 (22.8%)	44 (24.4%)
Astigmatism ≥1DC	52 (26.4%)	45 (25.0%)
Anisometropia≥1DS	27 (13.7%)	23 (12.8%)
Aniso-astigmatism ≥1DC	17 (8.6%)	17 (9.4%)

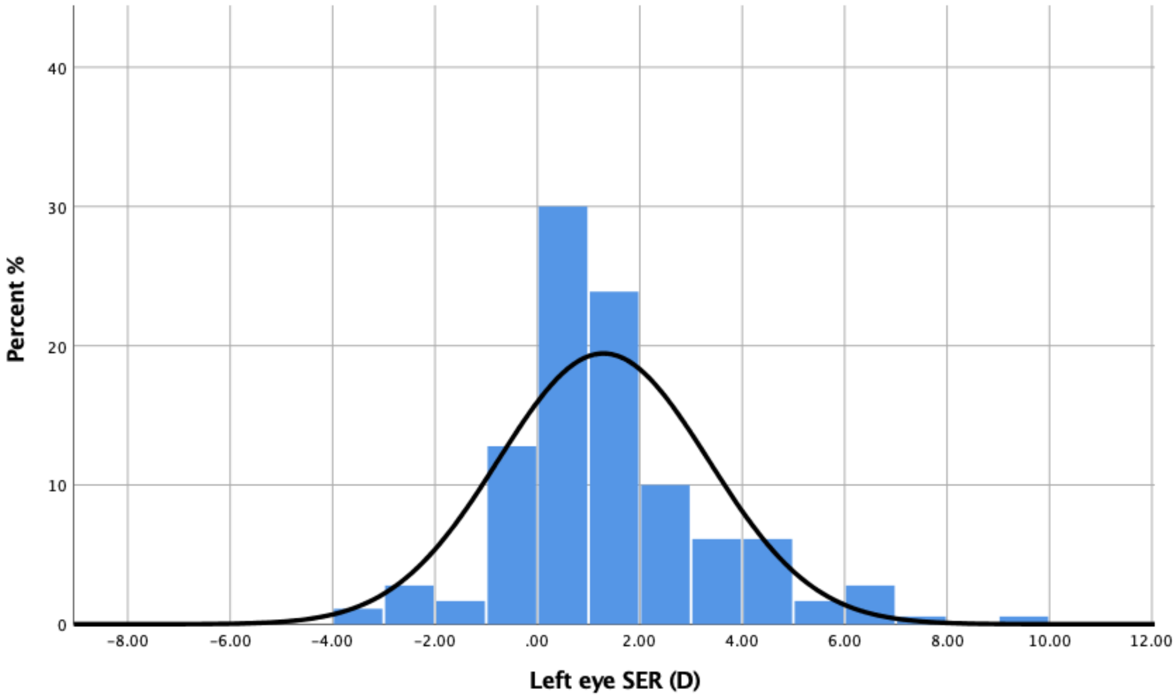
Table 6. *Refractive error distribution in participants including and excluding those who had a non-cycloplegic refraction. N.B. based on least ametropic eye and participants may appear in more than one category.*

Only data from participants who had a cycloplegic refraction (n=180) are presented in the following analyses of refractive error.

6.3.1.1. Distribution of spherical equivalent refractive error (SER)

Graph 6 And Table 6.1. show that SER is not normally distributed.



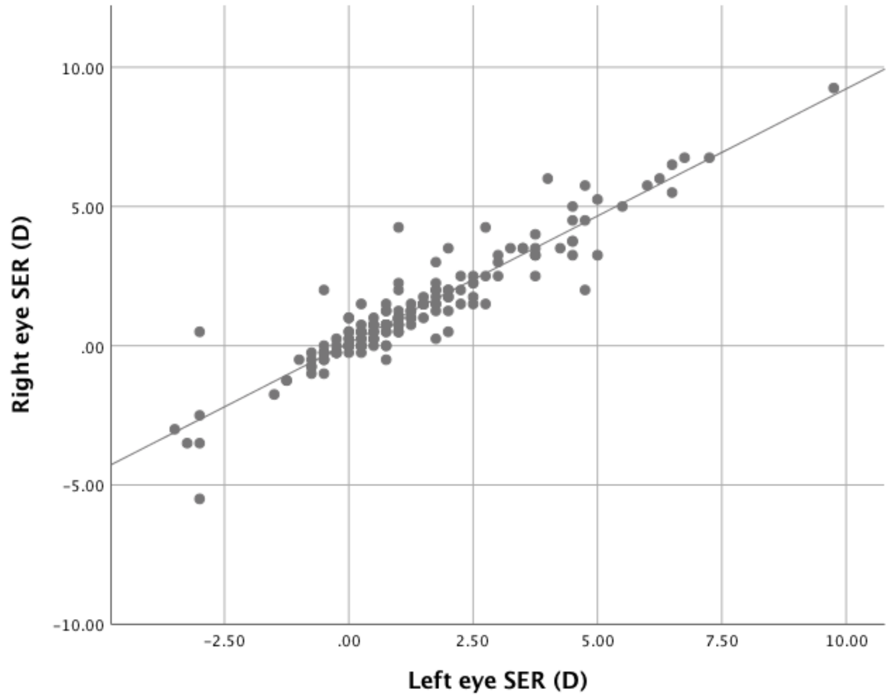


Graph 6. *Histogram showing the distribution of SER for right and left eyes. N.B. the black line represents expected values if the data have a normal distribution.*

	Right eye	**Left eye**
Mean SER (D) ±SD	+1.27	+1.26
Median (D)	+0.75	+1.00
5th – 95th percentiles	-1.00 to +5.50	-1.25 to +5.00
Skew	4.19 **(p<0.001)**	5.03 **(p<0.001)**
Kurtosis	6.65 **(p<0.001)**	5.54 **(p<0.001)**

Table 6.1. *Distribution of SER*

Graph 6.1 shows SER to be correlated between the left and right eyes (r_p=0.936**,** p<0.001), therefore only data from the left eye have been used here and in subsequent analyses.



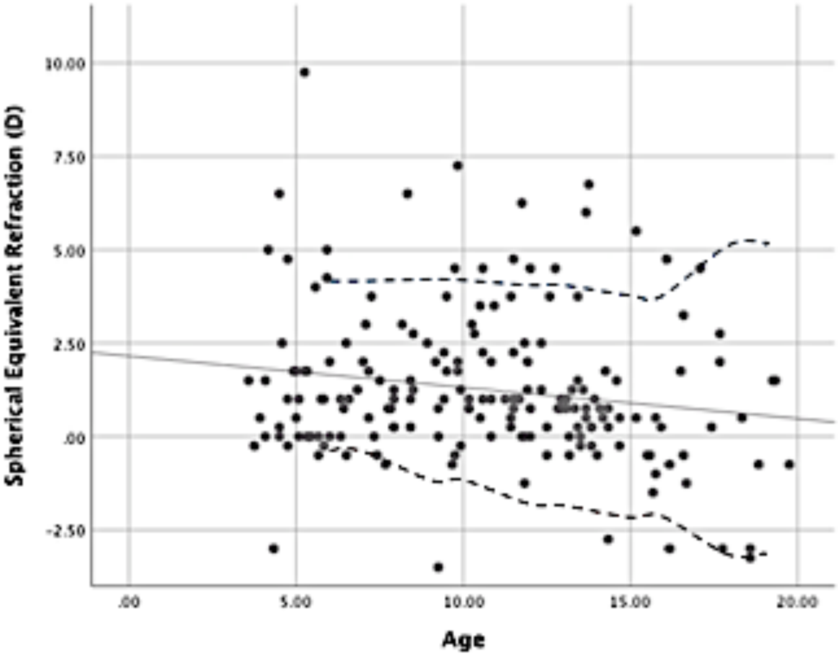
Graph 6.1. *Correlation of SER for left and right eyes.*

6.3.1.2. Gender and distribution of SER

The median SER was more hyperopic in males (*Md*=+1.00D, n=125) than in females (*Md*=+0.75D, n=125) but this difference was not statistically significant (Mann-Whitney U=3002, p=0.175).

6.3.1.3. Age and distribution of SER

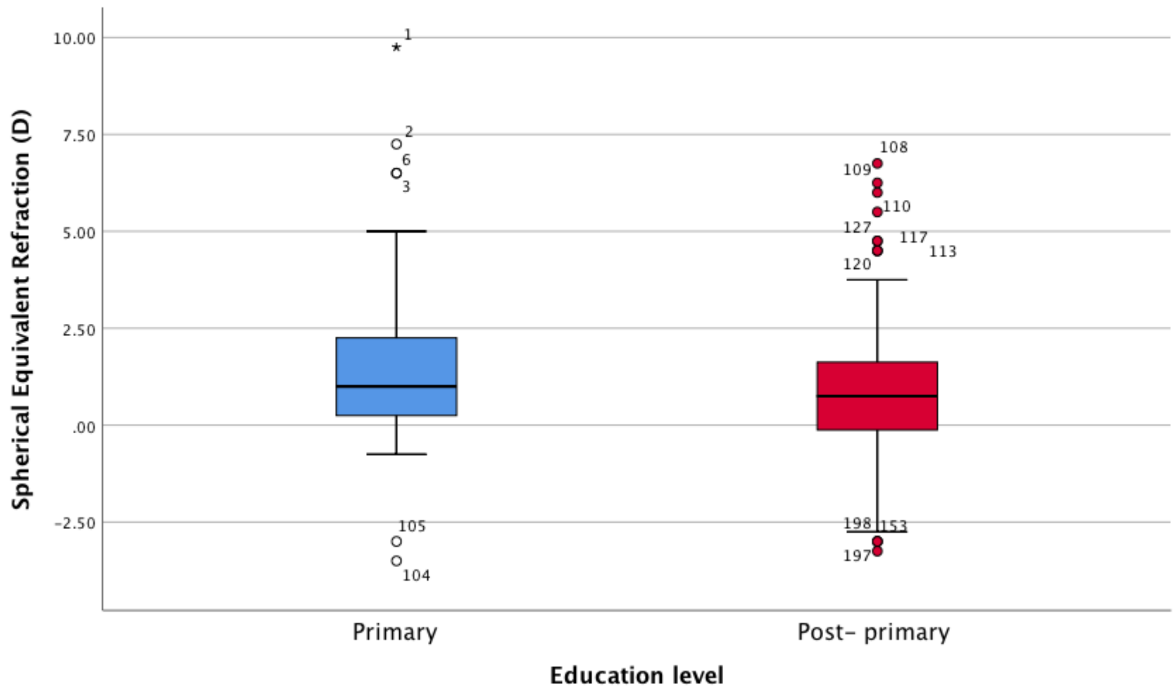
Graph 6.2. displays the distribution of SER in participants across all ages. On average SER was more myopic amongst the older children however the relationship between age and SER was not statistically significant (r_p=-0.104, p=0.112).



Graph 6.2. *Distribution of SER for participants of all ages. The dark dashed lines represent the 5th and 95th percentile normative values derived from the NICER study* (*O'Donoghue et al., 2010b; McCullough et al., 2014; Breslin et al., 2013)*

6.3.1.4. Education level and distribution of SER

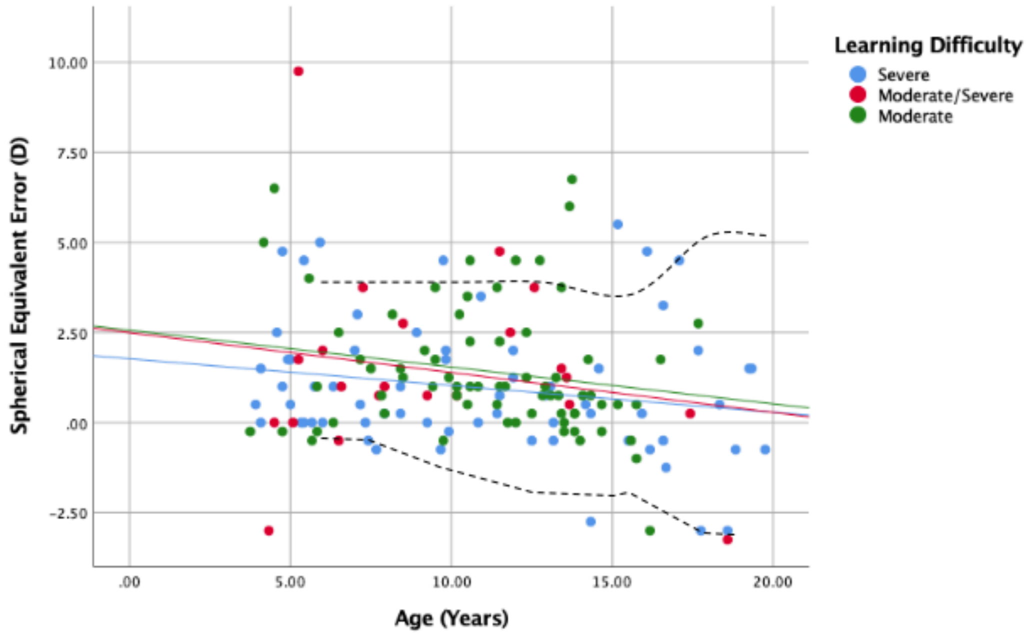
Graph 6.3. illustrates the distribution of SER in Primary and Post-primary participants**.** A Mann-Whitney U Test revealed a statistically significant difference between the SER of Primary children (*Md*=+1.00D, n=97) and Post-primary children (*Md*=+0.75D n=83), U=3233, z=-2.278, **p=0.023**, r=0.17 with Primary children having a more hyperopic SER than Post- primary children.



Graph 6.3. *Boxplot illustrating the distribution of SER in Primary and Post-primary participants.*

6.3.1.5. Level of learning difficulty and distribution of SER

Graph 6.4. demonstrates the distribution of SER across all ages of participants with severe (SLD), moderate to severe (MLD/SLD) and moderate (MLD) learning difficulties. Participants with complex, profound, delayed and mild to moderate learning difficulties were omitted from analyses due to small group sizes, i.e. n≤ 2.



Graph 6.4. *Distribution of SER for participants with a learning difficulty. The dark dashed lines represent the 5th and 95th percentile normative values obtained from the NICER study.*

A Kruskal-Wallis Test revealed no significant difference between the learning difficulty groups in terms of SER (SLD, *Md*= +0.50D, n=65: MLD/SLD, *Md*=+1.00D, n=22: MLD, Md=+1.00D, n=71) p=0.168. χ^2 [2]=3.572.

6.3.1.6. Distribution of SER by diagnosis

Table 6.2. displays the distribution of SER for participants with a diagnosis of autism, Down syndrome, cerebral palsy and epilepsy in addition to participants with 'no/other' diagnosis.

	Autism (n=52)	Down syndrome (n=16)	Cerebral Palsy (n=4)	Epilepsy (n=9)	No/ other diagnosis (n=99)
Md SER (D)	+0.63	+2.25	+2.13	+1.25	+1.00
IQR SER (D)	0.00 to +1.50	+0.25 to +4.31	-2.19 to +2.69	-0.13 to +4.00	+0.25 to +2.00
Myopia ≤ -0.50D (%)	11.5%	12.5%	25.0%	11.1%	9.1%
Hyperopia ≥+2.00D (%)	11.5%	50.0%	50%	44.4%	24.5%
Astigmatism ≥1.00DC (%)	21.2%	56.3%	50%	44.4%	19.2%
Anisometropia ≥1.00D (%)	19.2%	6.3%	0%	0%	12.1%
Aniso-astigmatism ≥1.00DC (%)	9.6%	12.5%	0%	22.2%	8.1%

Table 6.2. *SER of participants with autism, Down syndrome, cerebral palsy and epilepsy and those with 'no/other' diagnosis. Participants SP111 and SP192 had a dual diagnosis of autism and epilepsy and SP033 had a dual diagnosis of autism and Down syndrome. In this instance autism was considered the primary need for these three participants.*

The prevalence of hyperopia and astigmatism was considerably higher in participants with Down syndrome, cerebral palsy and epilepsy compared to participants with 'no/other' diagnosis. The prevalence of hyperopia in participants with autism however was half the percentage reported in participants with 'no/other' diagnosis.

Despite this, a Kruskal Wallis test revealed no statistically significant difference between SER and diagnosis, $\chi^2[4]= 8.891$ $p=0.064$.

6.3.1.7. Is SER outside the 'normal' range associated with age, gender, education level, severity of learning difficulty or diagnosis?

Thirty-one participants had a SER outside the normal range as defined by the NICER data (O'Donoghue *et al.*, 2010b; McCullough *et al.,* 2014; Breslin *et al.,* 2013). No statistically significant difference was found in the age of participants who presented with SER outside the normal range and those who presented with SER within the normal range (Mann-Whitney U=1657, z=-0.515, p=0.606).

Chi-squared tests revealed no statistically significant relationship between the gender (p=0.385), education level (p=1.00), severity of learning difficulty (p=0.597) or diagnosis (p>0.05*) of participants with a SER outside normal ranges.

*(*Autism (p=0.094), epilepsy (p=1.00), Down syndrome (p=0.088), cerebral palsy (p= 1.00), speech and language problems (p=0.855), hearing impairment (p=0.655))*

6.3.1.8. Is uncorrected refractive error associated with age, gender, education level, severity of learning difficulty or diagnosis?

Seventy-nine participants (43.8%) presented with a refractive error as defined in Table 6. Thirty-four of whom (43%) presented to the baseline assessment uncorrected.

Participants presenting with uncorrected refractive error (*Md*=9.83years old, n=34) were significantly younger than participants who presented with corrected refractive error (*Md*=12.33, n=45), Mann-Whitney U=535.5, z=-2.273, **p=0.023**, r=0.26.

Table 6.3. details the outcomes of statistical analyses employed to investigate characteristic associations with uncorrected refractive error.

Category		Did the participant present with uncorrected refractive error?		
		No n(%)	**Yes n(%)**	**Chi-squared test**
Gender	Male	30(54.5%)	25(45.5%)	$\chi^2[1]=0.168$, p=0.682*
	Female	15(62.5%)	9(37.5%)	
Education level	Primary	19(46.3%)	22(53.7%)	$\chi^2[1]=3.073$, p=0.800*
	Post-primary	26(68.4%)	12(31.6%)	
Level of learning difficulty	Severe	14(43.8%)	18(56.3%)	$\chi^2[1]=5.535$, p=0.063**
	Moderate/ Severe	6(54.5%)	5(45.5%)	
	Moderate	20(74.1%)	7(25.9%)	
Autism	Yes	6(31.6%)	13(68.4%)	$\chi^2[1]=5.164$, **p=0.023***
	No	34(65.4%)	18(31.6%)	
Down Syndrome	Yes	6(50%)	6(50%)	$\chi^2[1]=0.045$, p=0.831*
	No	35(58.3%)	25(47.1%)	
Epilepsy	Yes	4(66.7%)	2(33.3%)	Fisher's exact, p=0.693
	No	37(56.1%)	29(43.9%)	
Cerebral Palsy	Yes	1(33.3%)	2(66.7%)	Fisher's exact, p=0.574
	No	40(58.0%)	29(42.0%)	
Speech and language	Yes	25(50%)	25(50%)	$\chi^2[1]=2.358$, p=0.125*
	No	16(72.7%)	6(27.3%)	
Hearing impairment	Yes	3(75%)	1(25%)	Fisher's exact, p=0.629
	No	38(55.9%)	30(44.1%)	

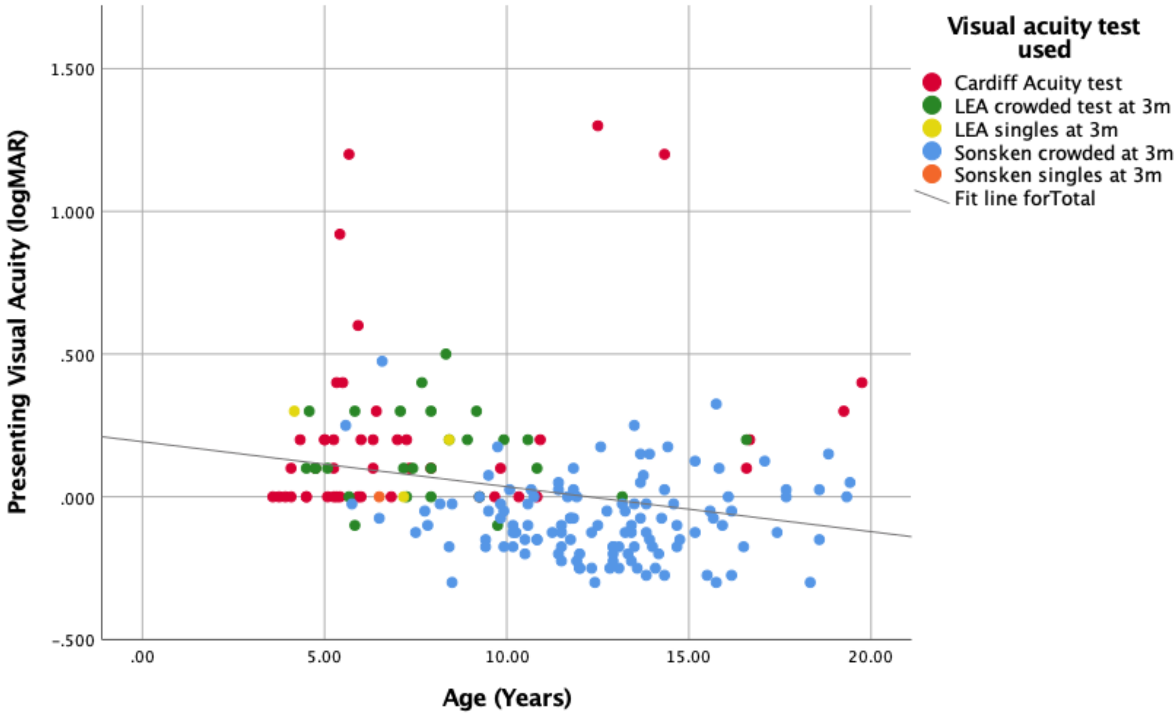
Table 6.3. *Is uncorrected refractive error associated with gender, education level, level of learning difficulty and diagnosis? *=Continuity correction, **= Pearson Chi-square.*

Participants with autism were more likely to present with an uncorrected refractive error compared to other participants ($\chi^2[1]=5.164$, **p=0.023**).

6.3.2. Presenting visual acuity (PVA) and Near presenting visual acuity (near-PVA)

6.3.2.1. Age and PVA

Graph 6.5. illustrates the distribution of PVA in project participants (n=197).

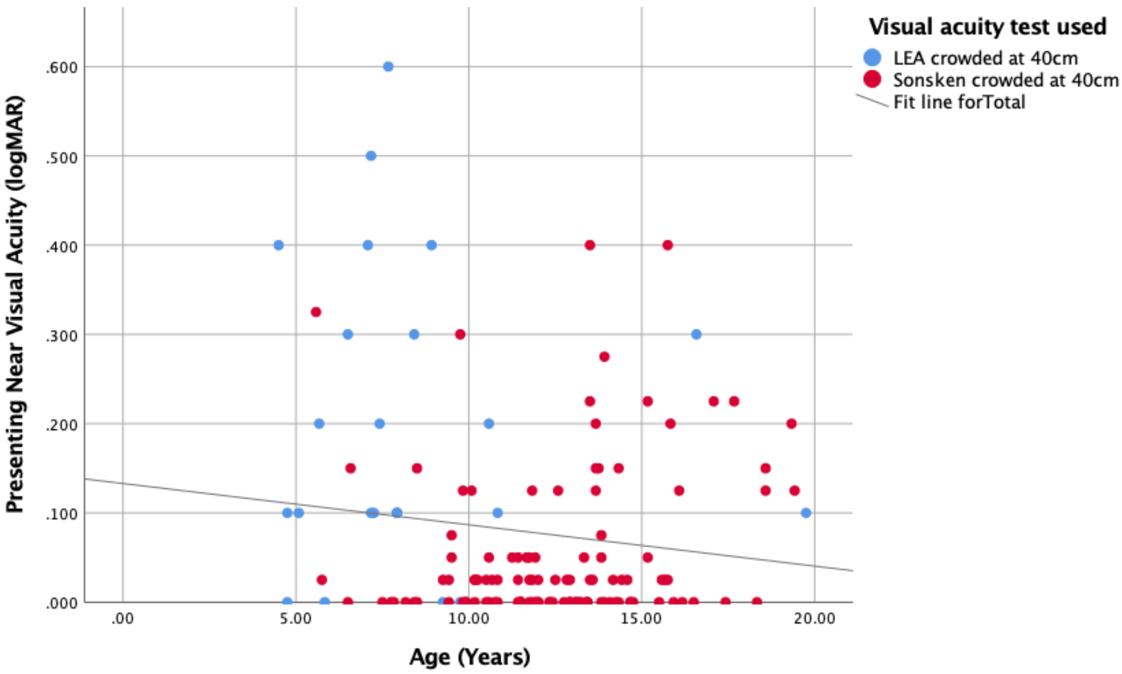


Graph 6.5. *Graph demonstrating the distribution of PVA amongst participants (n=197).*

There was significant correlation between PVA and age with PVA improving with age (r_p=-0.263, p<0.001).

6.3.2.2. Age and near-PVA

Graph 6.6. illustrates the distribution of age and near-PVA. There is no significant correlation between age and near-PVA (r_p=-0.132, p=0.119).



Graph 6.6. *Distribution of Near-PVA vs Age*

6.3.2.3. Gender, severity of learning difficulty, diagnosis and PVA/near-PVA

Table 6.4. displays the PVA and near-PVA of participants as categorised by gender, severity of learning difficulty and diagnosis.

Category		PVA (logMAR)		Statistical tests	Near-PVA (logMAR)		Statistical tests
		Median	**IQR**		**Median**	**IQR**	
Gender	Male	0.000	-0.150 to 0.100	Mann-Whitney p=0.062	0.025	0.000 to 0.100	Mann-Whitney **U=1427, p=0.002, z=-3.063, r=0.26**
	Female	0.000	-0.125 to 0.200		0.088	0.000 to 0.225	
Level of learning difficulty	Severe	0.100	0.000 to 0.200	Kruskal Wallis **χ2[2]= 33.686, p<0.001**	0.100	0.000 to 0.225	Kruskal Wallis **χ2[2]= 9.215, p=0.010**
	Moderate/ Severe	0.000	-0.100 to 0.100		0.025	0.000 to 0.125	
	Moderate	-0.100	-0.175 to 0.000		0.013	0.000 to 0.050	
Diagnosis	None/other	-0.050	-0.150 to 0.050	Kruskal Wallis **χ2[4]= 31.189, p<0.001**	0.025	0.000 to 0.125	Kruskal Wallis **χ2[4]= 20.314, p<0.001**
	Autism	0.000	-0.144 to 0.100		0.000	0.000 to 0.025	
	Down syndrome	0.200	0.150 to 0.300		0.113	0.050 to 0.300	
	Cerebral palsy	0.150	-		0.338	-	
	Epilepsy	0.150	-0.075 to 0.200		0.200	0.000 to 0.263	
Speech and language	Yes	0.000	-0.100 to 0.150	Mann-Whitney **U=2779, p=0.006, z=-2.725, r=0.20**	0.025	0.000 to 0.125	Mann-Whitney p=0.927
	No	-0.100	-0.188 to 0.100		0.025	0.000 to 0.125	
Hearing impairment	Yes	0.200	0.088 to 0.275	Mann-Whitney **U=183, p=0.025, z=-2.240, r=0.17**	0.363	0.175 to 0.400	Mann-Whitney **U=37.5, p=0.002, z=-3.040, r=0.26**
	No	0.000	-0.138 to 0.100		0.025	0.000 to 0.100	

Table 6.4. *PVA and near-PVA of participants as categorised by gender, severity of learning difficulty and diagnosis.*

6.3.2.4. Gender and PVA/near-PVA

There was no significant difference in the PVA of male (n=138) and female (n=59) participants. However, a statistically significant difference was shown between the near-PVA of males (n=99) and females (n=42). Females presented with poorer near visual acuity than males (U=1427, z=-3.063, **p=0.002**, r=0.26).

6.3.2.5. Severity of learning difficulty and PVA/near-PVA

A Kruskal-Wallis test revealed statistically significant differences between the PVA of learning difficulty groups, $\chi^2[2]= 33.686$, **p<0.001**. Bonferroni correction showed the difference to be between the SLD (n=67) and MLD group (n=80); participants with SLD presented with statistically significantly poorer acuity than participants with MLD (Mann-Whitney U=1247.50**, p<0.001**, z=-2.841, r=0.27).

Statistically significant differences were also shown in the near-PVA between learning difficulty groups (Kruskal-Wallis, $\chi 2[2]=9.215$, **p=0.010**). Bonferroni correction showed the difference be between participants with SLD (n=35) and with MLD (n=72). Participants with SLD presented with statistically significantly poorer near-PVA compared to participants with MLD (Mann-Whitney U=834, z=-2.956, **p=0.003**, r=0.29).

6.3.2.6. Diagnosis and PVA/near-PVA

A Kruskal-Wallis test revealed statistically significant differences between the PVA of diagnosis groups, $\chi^2[4]= 31.189$, **p<0.001**. Bonferroni correction showed the difference to be between participants with Down syndrome (n=17) and participants with 'no/other' diagnosis (n=108) in addition to participants with autism (n=60); Mann-Whitney U= 204, z=-5.151, **p<0.001**, r=0.46 and Mann-Whitney U=129, z=-4.711, **p<0.001**, r=0.54 respectively.

Participants with Down syndrome presented with statistically significantly poorer PVA than both participants with 'no/other' diagnosis and participants with autism.

Statistically significant differences were also shown in the near-PVA between diagnosis groups (Kruskal-Wallis, $\chi 2[4]=20.14$, **p<0.001**). Bonferroni correction showed the difference to be between participants with autism (n=38) and participants with Down syndrome (n=10). Participants with autism presented with statistically significantly better near-PVA compared to participants with Down syndrome (Mann-Whitney U=42.500, z=-3.934, **p<0.001**, r=0.57).

Participants with Speech and Language difficulties (n=121) were more likely to present with poorer PVA compared to other participants; Mann-Whitney U=2779, **p=0.006**, z=-2.725, r=20. There was no statistically significant difference in the near-PVA of participants with and without speech and language difficulties.

Participants with hearing impairment (n=5) were statistically significantly more likely to present with poorer PVA and near-PVA compared to other participants; Mann-Whitney U=183, **p=0.025**, z=-2.240, r=0.017 and Mann-Whitney U=37.5, **p=0.002**, z=-3.040, r=0.26 respectively.

6.3.2.7. Is PVA outside the 'normal' range associated with age, gender, education level, severity of learning difficulty or diagnoses?

Thirty-eight (19.3%) participants for whom a PVA measure was obtained demonstrated PVA outside the normal range as determined by comparison of the child's data with published test-specific data for the test used to measure acuity. Twelve participants (6%) presented with acuity >0.3logMAR, five (2.5%) of whom presented with acuity >0.5logMAR..

There was no significant difference in the age of participants with ‘normal’ PVA (*Md*=11.25years, n=159) and participants with PVA outside the normal range (*Md*=9.38years, n=38), Mann-Whitney U, p=0.521.

Table 6.5. explores the association of gender, education level, severity of learning difficulty and diagnoses with PVA outside the normal range.

Category		Is PVA outside the normal range?		
		No n(%)	**Yes n(%)**	**Chi-squared test**
Gender	Male	117(84.8%)	21(15.2%)	$\chi^2[1]=4.073$, **p=0.044***
	Female	42(71.2%)	17(28.8%)	
Education level	Primary	81(77.9%)	23(22.1%)	$\chi^2[1]=0.778$, p=0.378*
	Post-primary	78(83.9%)	15(16.1%)	
Level of learning difficulty	Severe	50(74.6%)	17(25.4%)	$\chi^2[2]=3.737$, p=0.154**
	Moderate/ Severe	20(74.1%)	7(25.9%)	
	Moderate	11(86.3%)	69(13.8%)	
Autism	Yes	53(88.3%)	7(11.7%)	$\chi^2[1]=3.540$ p=0.060*
	No	87(75.0%)	29(25.0%)	
Down Syndrome	Yes	6(33.3%)	12 (66.7%)	$\chi^2[1]=24.493$ **p<0.001***
	No	140(85.4%)	24(14.6%)	
Epilepsy	Yes	7(63.6%)	4(36.4%)	Fisher's exact test, p=0.232
	No	139(81.3%)	32(18.7%)	
Cerebral Palsy	Yes	2(66.7%)	1(33.3%)	Fisher's exact test, p=0.486
	No	144(80.4%)	35(19.6%)	
Speech and language	Yes	97(80.2%)	24(19.8%)	$\chi^2[1]=0.001$ P=0.979*
	No	49(80.3%)	12(19.7%)	
Hearing impairment	Yes	3(60%)	2(40%)	Fisher's exact test, p=0.257
	No	143(80.8%)	34(19.2%)	

Table 6.5. *Is Presenting Visual Acuity (PVA) outside the 'normal' range associated with gender, age, level of learning difficulty?*=Continuity correction, **= Pearson Chi-square.*

Females and participants with Down syndrome were more likely to present with visual acuity outside the test-defined normal range, (**p=0.044** and **p<0.001** respectively) compared with other participants.

6.3.2.8. Is Presenting near visual acuity (near-PVA) outside the 'normal' range associated with age, gender, education level, severity of learning difficulty or diagnoses?

Thirty-two (22.7%) of participants for whom a measure near-PVA was possible presented with near-PVA outside the normal range as determined by comparison of the child's data with published test-specific data for the test used to measure acuity.

No significant difference was found between the age of the participants with normal near-PVA (*Md*=11.92years, n=109) and those with near-PVA outside normal levels (*Md*=10.33yrs, n=32), Mann-Whitney U, p=0.435.

Table 6.6. explores the association of gender, education level, severity of learning difficulty and diagnoses with near-PVA outside the normal range.

Category		Is near- PVA outside the normal range?		
		No n(%)	Yes n(%)	Chi-squared test
Gender	Male	85(85.9%)	14(14.1%)	$\chi^2[1]=13.860$, **p<0.001***
	Female	24(57.1%)	18(42.9%)	
Education level	Primary	41(70.7%)	17(29.3%)	$\chi^2[1]=1.859$, p=0.173*
	Post-primary	68(81.9%)	15(18.1%)	
Level of learning difficulty	Severe	23(65.7%)	12(34.3%)	$\chi^2[2]=3.048$, p=0.218**
	Moderate/ Severe	16(80%)	4(20%)	
	Moderate	58(80.6%)	14(19.4%)	
Autism	Yes	34(89.5%)	4(10.5%)	Fisher's exact test**, p=0.023**
	No	61(70.1%)	26(29.9%)	
Down Syndrome	Yes	6(60.0%)	4(40.0%)	Fisher's exact test, p=0.234
	No	96(78.7%)	26(21.3%)	
Epilepsy	Yes	3(42.9%)	4(57.1%)	Fisher's exact test**, p=0.047**
	No	99(79.2%)	26(20.8%)	
Cerebral Palsy	Yes	0%	2(100%)	Fisher's exact test**, p=0.050**
	No	102(78.5%)	28(21.5%)	
Speech and language	Yes	59(75.6%)	19(24.4%)	$\chi^2[1]=0.107$, p=0.744*
	No	43(79.6%)	11(20.4%)	
Hearing impairment	Yes	1(25.0%)	3(75.0%)	Fisher's exact test**, p=0.037**
	No	101(78.9%)	27(21.1%)	

Table 6.6. *Is near-PVA outside the 'normal' range associated with gender, education level, severity of learning difficulty and diagnosis? *=Continuity correction, **= Pearson Chi-square.*

Participants were more likely to present with near-PVA outside the normal range if they had a hearing impairment (**p=0.037**), cerebral palsy (**p=0.050**), epilepsy (**p=0.047**) or were female (**p<0.001**). Participants with autism were more likely to present with normal near-PVA (**p=0.023**).

6.3.3. Contrast Sensitivity

6.3.3.1. Is reduced contrast sensitivity associated with age, gender, education level, severity of learning difficulty or diagnoses?

Thirty participants (16.4%) presented with reduced contrast sensitivity as classified by test normative data (Chapter 3). Table 6.7. explores whether reduced contrast sensitivity is associated with gender, education level, severity of learning difficulty or diagnosis.

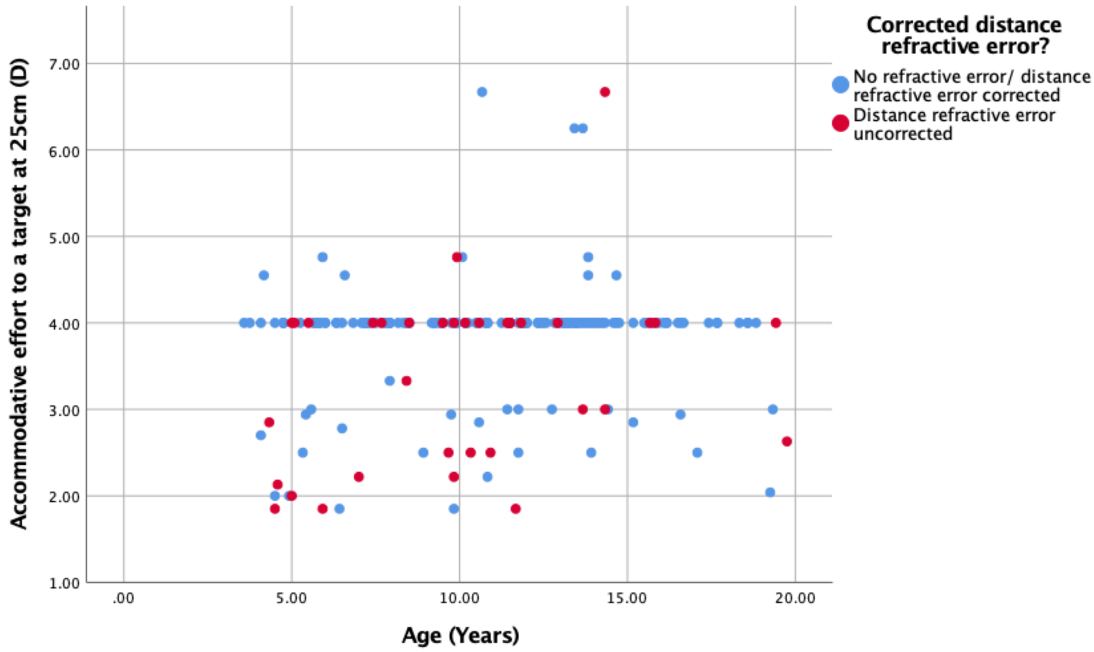
		Is contrast sensitivity reduced?		
		No n(%)	**Yes n(%)**	Chi-squared test
Gender	Male	107(82.3%)	23(17.7%)	$\chi^2[1]=2.74$, p=0.601*
	Female	46(86.8%)	7(13.2%)	
Education level	Primary	69(73.4%)	25(26.6%)	$\chi^2[1]=13.188$, **p<0.001***
	Post- primary	84(94.4%)	5(5.6%)	
Level of learning difficulty	SLD	40(69.0%)	18(31.0%)	$\chi^2[2]=13.119$, **p=0.001****
	MLD/SLD	21(84.0%)	4(16.0%)	
	MLD	74(92.5%)	6(7.5%)	
Autism	Yes	47(85.5%)	8(14.5%)	$\chi^2[1]=0.00$, p=0.988*
	No	93(86.9%)	14(13.1%)	
Down Syndrome	Yes	12(66.7%)	6(33.3%)	$\chi^2[1]=8.130$, **p=0.004***
	No	151(90.4%)	16(9.6%)	
Epilepsy	Yes	7(70%)	3(30%)	Fisher's exact test, p=0.125
	No	140(88.1%)	19(11.9%)	
Cerebral Palsy	Yes	2(100%)	0	Fisher's exact test, p=1.00
	No	145(86.8%)	22(13.2%)	
Speech and language	Yes	93(84.5%)	17(15.5%)	$\chi^2[1]=1{,}093$, p=0.296*
	No	54(91.5%)	5(8.5%)	
Hearing impairment	Yes	3(100%)	0	Fisher's exact p=1.00
	No	144(86.7%)	22(13.3%)	

Table 6.7. *Is reduced contrast sensitivity associated with gender, education level, severity of learning difficulty and diagnosis? *=Continuity correction, **= Pearson Chi-square.*

Participants were more likely to present with reduced contrast sensitivity if they were educated to primary level (p<0.001), had SLD (p=0.001) or had a diagnosis of Down syndrome (p=0.004).

6.3.4. Presenting accommodative accuracy

Presenting accommodative accuracy was successfully measured in 97.0% (194) of participants. Graph 6.7. illustrates the presenting accommodative accuracy of participants; blue represents participants who have no refractive error or were wearing distance correction for the measurement, red represents those with a refractive error but not wearing spectacles for the measurement.



Graph 6.7. *Scattergraph displaying the distribution of Presenting accommodative accuracy in participants; blue represents participants who have no refractive error or were wearing distance correction for the measurement, red represents those with a refractive error but were not wearing spectacles for the measurement.*

6.3.4.1. Accommodative accuracy

True accommodative accuracy is determined when refractive error is corrected where present. Therefore, those participants who presented with an uncorrected refractive error (n=36) are omitted from subsequent analyses.

6.3.4.2. Age and accommodative accuracy

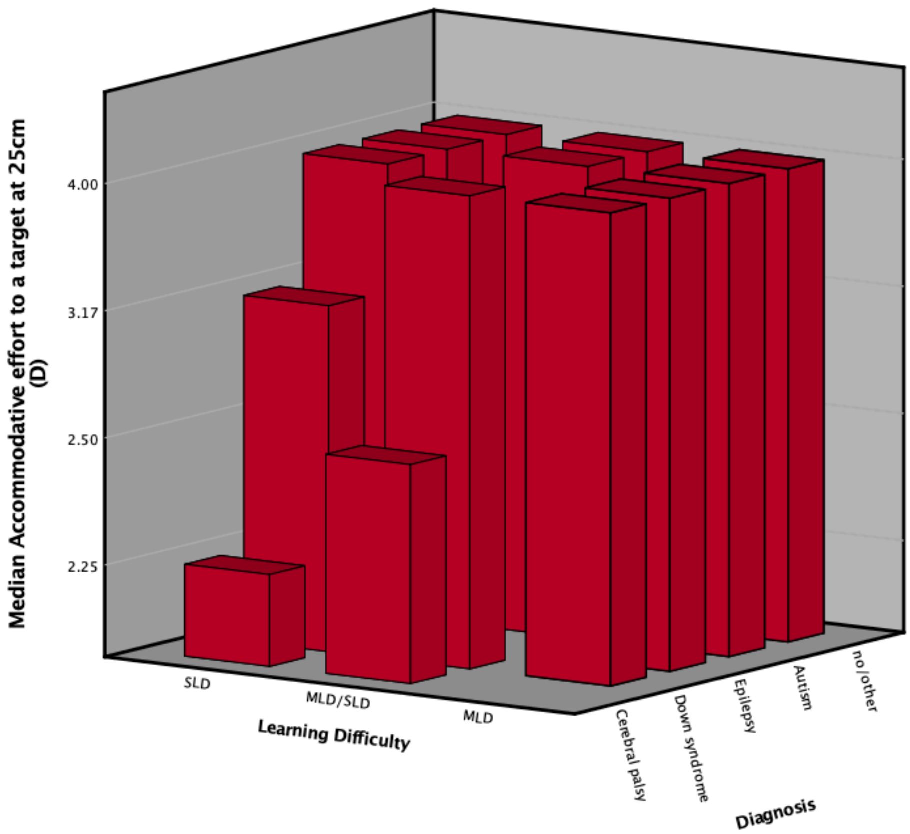
There was no correlation between age and accommodative accuracy (r_p=0.079, p=3.22).

6.3.4.3. Gender and accommodative accuracy

There was no significant difference in accommodative accuracy of male (*Md*= 4.00D, n=108) and female (*Md*=4.00D, n=50) participants (Mann-Whitney U=3618.5, p=0.309).

6.3.4.4. Learning difficulty, diagnosis and accommodative accuracy

Graph 6.8. demonstrates accommodative accuracy of participants in relation to level of learning difficulty and associated diagnosis.



Graph 6.8. *Bar chart demonstrating the median accommodative accuracy of participants with SLD, MLD/SLD and MLD and associated diagnosis*

A Kruskal-Wallis test revealed a statistically significant difference between participants with learning difficulties of differing severity ($\chi^2[2]=7.453$, **p=0.024**). Bonferroni correction revealed the difference was between participants with SLD (n=49) and participants with MLD (n=69). Participants with SLD were more likely to under-accommodate to a target of 25cm compared to participants with MLD (Mann-Whitney U=1320, z=-2.833, **p=0.005**, r=0.26).

A statistically significant difference between diagnostic groups was shown using a Kruskal-Wallis test, (χ^2 [4]=24.175, **p<0.001**). Mann-Whitney U tests showed the difference to lie between participants with cerebral palsy n=3 and participants with 'no/other' diagnosis n=91 U=7.00 z=-3.755, **p<0.001**.

Participants with cerebral palsy were more likely to underaccommodate to a target of 25cm compared to participants with 'no/other' diagnosis.

6.3.4.5. Is accommodative accuracy outside the 'normal' range associated with age, gender, education level, severity of learning difficulty or diagnosis?

Thirty (19.0%) participants presented with an accommodative accuracy outside the normal range; 20 (12.7%) were under-accommodating.

There was no significant difference in the age of participants with normal accommodative accuracy (*Md*=11.50years, n=128) and those with an accommodative accuracy outside the normal range (*Md*=10.33years, n=30), Mann Whitney U, p=0.288.

Table 6.8. explores the association of gender, education level, severity of learning difficulty and diagnoses with normal accommodative accuracy.

Category		Is accommodative accuracy normal?		
		No n(%)	Yes n(%)	Chi-squared test
Gender	Male	33(24.1%)	104(75.9%)	$\chi^2[1]=0.073$, p=0.788*
	Female	12(21.1%)	45(78.9%)	
Education level	Primary	30(29.1%)	73(70.9%)	$\chi^2[1]=3.654$, p=0.056*
	Post-primary	15(16.5%)	76(83.5%)	
Level of learning difficulty	Severe	18(27.3%)	48(72.7%)	$\chi^2[2]=5.070$, p=0.079**
	Moderate/ Severe	9(33.3%)	18(66.7%)	
	Moderate	12(22.7%)	67(84.8%)	
Autism	Yes	12(21.1%)	45(78.9%)	$\chi^2[1]=0.320$ p=0.572*
	No	30(26.3%)	84(73.7%)	
Down Syndrome	Yes	11(61.1%)	7(38.9%)	$\chi^2[1]=13.550$, **p=<0.001***
	No	31(19.3%)	130(80.75)	
Epilepsy	Yes	2(20%)	8(80%)	Fisher's exact test, p=1.00
	No	40(23.7%)	129(76.3%)	
Cerebral Palsy	Yes	3(100%)	0	**Fishers exact test =0.003**
	No	38(21.7%)	137(78.3%)	
Speech and language	Yes	30(25.2%)	89(74.8%)	$\chi^2[1]=0.348$, p=0.555*
	No	12(20%)	48(80%)	
Hearing impairment	Yes	3(60%)	2(40%)	Fisher's exact =0.085
	No	39(22.4%)	135(77.6%)	

Table 6.8. *Is accommodative accuracy outside the 'normal' range associated with gender, age, level of learning difficulty? *=Continuity correction, **= Pearson Chi-square.*

Participants with Down syndrome and cerebral palsy were more likely to present with abnormal accommodative accuracy compared to participants without a diagnosis of Down syndrome (**p<0.001** and **p=0.003** respectively).

6.3.5. Eye movement and control

Ocular eye movements and control were assessed in 195 participants. Thirty-one participants (15.9%) presented with abnormal eye movements and/or abnormal control (nine had nystagmus, eight had reduced NPC, thirteen had abnormal pursuit and/or saccadic eye movements).

6.3.5.1. Are abnormal eye movements and control associated with age, gender, education level, severity of learning difficulty or diagnosis?

There was no significant difference in the age of participants with normal eye movements and control (*Md*=10.83yrs, n=164) and those with abnormal eye movement and control (*Md*=11.67yrs, n=31), Mann-Whitney U, p=0.307.

Table 6.9. explores the relationship between gender, education level, severity of learning difficulty and diagnosis with abnormality of eye movements and control.

Category		Are eye movements and control abnormal?		
		No n(%)	Yes n(%)	Chi-squared test
Gender	Male	117(86%)	19(14%)	$\chi^2[1]=0.817$, p=0.366*
	Female	47(79.7%)	12(20.3%)	
Education level	Primary	87(86.1%)	14(13.9%)	$\chi^2[1]=0.145$, p=0.703*
	Post-primary	77(81.9%)	17(18.1%)	
Level of learning difficulty	Severe	55(84.6%)	10(15.4%)	$\chi^2[2]= 0.181$, p=0.914**
	Moderate/ Severe	22(81.5%)	5(18.5%)	
	Moderate	67(84.8%)	12(15.2%)	
Autism	Yes	51(91.1%)	5(8.9%)	$\chi^2[1]=2.935$, p=0.087*
	No	92(79.3%)	24(20.7%)	
Down Syndrome	Yes	13(72.2%)	5(27.8%)	$\chi^2[1]=1.169$, p=0.280*
	No	138(85.2%)	24(14.8%)	
Epilepsy	Yes	7(70%)	3(30%)	Fisher's exact test, p=0.205
	No	144(84.7%)	26(15.3%)	
Cerebral Palsy	Yes	1(25%)	3(75%)	Fisher's exact test, **p=0.014**
	No	150(85.2%)	26(14.8%)	
Speech and language	Yes	97(82.2%)	21(17.8%)	$\chi^2[1]=0.404$, p=0.525**
	No	54(87.1%)	8(12.9%)	
Hearing impairment	Yes	4(100%)	0 (0%)	Fisher's exact test, p=1.00
	No	147(83.5%)	29(16.5%)	

Table 6.9. *Are abnormal eye movements and control associated with gender, age, level of learning difficulty? *=Continuity correction, **= Pearson Chi-square.*

Participants with cerebral palsy were more likely to present with abnormal eye movement and control compared to other participants (Fisher's exact test, **p=0.014).**

6.3.6. Ocular alignment

The ocular alignment of participants is summarised in Table 6.10. Thirty-nine (15.5%) participants had a manifest strabismus.

	Success rate		
Ocular alignment at distance	99.5% (n=199)	Esotropia	9.0% (n=18)
		Exotropia	8.0% (n=16)
		Vertical tropia	1.0% (n=1)
Ocular alignment at near	100% (n=200)	Esotropia	7.5% (n=15)
		Exotropia	7.5% (n=15)
		Vertical tropia	1.0% (n=2)

Table 6.10. *Ocular alignment of participants without spectacles.*

6.3.6.1. Is strabismus associated with age, gender, education level, severity of learning difficulty or diagnosis?

There is no significant difference in the age of participants with no manifest strabismus (*Md*=10.83yrs, n=161) and those with a manifest strabismus (*Md*=9.83yrs, n=39), Mann-Whitney U, p=0.633.

Table 6.11. explores the association between gender, education level, severity of learning difficulty and diagnosis with manifest strabismus.

Category		Does the participant have a manifest strabismus?		
		No n(%)	**Yes n(%)**	**Chi-squared test**
Gender	Male	120(85.7%)	20(14.3%)	$\chi^2[1]=7.014$, **p=0.008***
	Female	41(68.3%)	19(31.7%)	
Education level	Primary	85(80.2%)	21(19.8%)	$\chi^2[1]=0.0$, p=1.00*
	Post-primary	76(80.9%)	18(19.1%)	
Level of learning difficulty	Severe	50(72.5%)	19(27.5%)	$\chi^2[2]=9.139$, **p=0.010****
	Moderate/ Severe	21(77.8%)	6(22.2%)	
	Moderate	73(91.3%)	7(8.8%)	
Autism	Yes	52(88.1%)	7(11.9%)	$\chi^2[1]=3.178$, p=0.075*
	No	89(75.4%)	29(24.6%)	
Down Syndrome	Yes	14(77.8%)	4(22.2%)	Fisher's exact test, p=0.756
	No	135(80.8%)	32(19.2%)	
Epilepsy	Yes	7(63.6%)	4(36.4%)	Fisher's exact test, p=0.229
	No	142(81.6%)	32(18.4%)	
Cerebral Palsy	Yes	2(40.0%)	3(60.0%)	Fisher's exact test, p=0.051
	No	147(81.7%)	33(18.3%)	
Speech and language	Yes	98(79.7%)	25(20.3%)	$\chi^2[1]=0.049$, p=0.824
	No	51(82.3%)	11(17.7%)	
Hearing impairment	Yes	2(40%)	3(60%)	Fisher's exact test, p=0.051
	No	147(81.7%)	33(18.3%)	

Table 6.11. *Is manifest strabismus associated with gender, education level, severity of learning difficulty and diagnosis? *=Continuity correction, **= Pearson Chi-square*

Statistically significant fewer children with MLD had a manifest strabismus compared to children with SLD and MLD/SLD, **p=0.010**. Females were more likely to present with a strabismus compared to males, **p=0.008**.

6.3.7. Stereoacuity

Sixty participants presented with stereoacuity outside the normal range. No statistically significant difference was found in the age of participants who presented with reduced stereoacuity (Mann-Whitney U, p=0.115).

Chi-squared tests revealed no significant relationship between the gender (p=0.100), education level (p=0.098), severity of learning difficulty (p=0.737) or diagnosis (p>0.05*) of participants with a SER outside normal ranges.

*(*Autism (p=0.329), epilepsy (p=0.711), Down syndrome (p=0.740), cerebral palsy (p= 0.058), speech and language problems (p=0.245), hearing impairment (p=0.151))*

6.3.8. Ocular health

Table 6.12. describes ocular deficits that were present in participants. 18 (9%) participants presented with an ocular health issue.

Ocular deficit	**n (%)**
Blocked tear ducts	4 (2%)
Blepharitis	3 (1.5%)
Ptosis	2 (1%)
Iris synechiae	1 (0.5%)
Cataract	2 (1%)
Disc atrophy	2 (1%)
Tortuous blood vessels	1 (0.5%)
Pale discs	1 (0.5%)
Pale fundus	1 (0.5%)

Table 6.12. *Ocular deficits detected in participants.*

6.3.8.1. Are ocular deficits associated with gender, education level, severity of learning difficulty or diagnosis?

Table 6.13. explores the association of gender, education level, severity of learning difficulty and diagnosis with whether the participant presented with an ocular deficit.

Category		**Does the participant have an ocular deficit?**		
		No n(%)	**Yes n(%)**	**Chi-squared test**
Gender	Male	132(94.3%)	8(5.7%)	$\chi^2[1]=4.887$, **p=0.027***
	Female	50(83.3%)	10(16.7%)	
Education level	Primary	95(89.6%)	11(10.4%)	$\chi^2[1]=0.226$, p=0.635*
	Post-primary	87(92.6%)	7(7.4%)	
Level of learning difficulty	Severe	63(91.3%)	6(8.7%)	$\chi^2[2]=4.736$, p=0.094**
	Moderate/ Severe	22(81.5%)	5(18.5%)	
	Moderate	76(95.0%)	4(5%)	
Autism	Yes	56(94.9%)	3(5.1%)	$\chi^2[1]=1.375$, p=0.241*
	No	104(88.1%)	14(11.9%)	
Down Syndrome	Yes	13(72.2%)	5(27.8%)	$\chi^2[1]=5.973$, **p=0.015***
	No	155(92.8%)	12(7.2%)	
Epilepsy	Yes	10(90.9%)	1(9.1%)	Fisher's exact test, p=1.00
	No	158(90.8%)	16 (9.2%)	
Cerebral Palsy	Yes	4(80%)	1(20%)	Fisher's exact test, p=0.386
	No	164(91.1%)	16(8.9%)	
Speech and language	Yes	113(91.9%)	10(8.1%)	$\chi^2[1]=1.87$, p=0.665
	No	55(88.7%)	7(11.3%)	
Hearing impairment	Yes	5(100%)	0	Fisher's exact test, p=1.00
	No	163(90.6%)	17(9.4%)	

Table 6.13. *Are there ocular deficits associated with gender, education level, severity of learning difficulty or diagnosis? *=Continuity correction, **= Pearson Chi-square*

Females and participants with Down syndrome were more likely to present with an ocular deficit (**p=0.027** and **p=0.015** respectively).

6.3.9. Colour vision

Six participants (3.6%) were identified as having abnormal colour vison i.e. red/green colour deficiency, all of whom were boys, 83.3% had MLD and 50% had autism.

6.3.10. Visual field defects

Visual field assessment was conducted in 187 (93.5%) of participants. Four (2.1%) participants presented with a visual field defect, three presented with hemianopia and one participant demonstrated a general constriction of their visual field. Three participants had cerebral palsy and one had epilepsy as a result of an acquired brain injury.

6.4. Discussion

6.4.1. Visual profile of children attending special educational schools in Northern Ireland

This is the first study to examine the visual profile of a SpEN population in Northern Ireland. Tables 6.14. and 6.15. compare the visual profiles of participants in the current study with other UK studies examining children with SpEN and typically developing children respectively.

	SpEN population			
	N. Ireland	**England**	**Wales**	**Scotland**
Visual Measure	**Present study**	**Donaldson et al., 2019**	**Woodhouse et al., 2014**	**Das et al., 2010**
Refractive error				
Myopia ≤-0.50DS	10.6%	22.3%	13.9%	9.6%
Hyperopia ≥+2.00DS	24.4%	15.2%	14.5%	22.8%
Astigmatism ≥1.00DC	25%	28.6%		
Astigmatism ≥0.75DC	33.3%		18.5%	32%
Presenting visual acuity				
>0.3logMAR	6%		13.9%	
≥0.5logMAR		24.9%		
>0.5logMAR	2.5%			12.1%
Near visual acuity ≥0.4logMAR	5%	*Not presented/ assessed*	*Not presented/ assessed*	*Not presented/ assessed*
Reduced contrast sensitivity	16.4%	*Not presented/ assessed*	*Not presented/ assessed*	*Not presented/ assessed*
Hypo-accommodation	12.7%	10.6%	14.3%	
Nystagmus	4.5%	2.4%	9.8%	4.5%
Manifest strabismus	15.5%	22.6%	22.1%	17.5%
Ocular abnormality/pathology	9%	7.6%	50%	3.9%
Visual field defect	2.1%	2.4%	*Not presented/assessed*	*Not presented/ assessed*
Colour vision defect	3.6%	*Not presented/ assessed*	*Not presented/assessed*	*Not presented/ assessed*

Table 6.14. *Visual profiles of participants in the current study and other UK studies examining children with SpEN.*

	SpEN population	Typically developing population		
	N.Ireland	N. Ireland	England	Ireland
Visual Measure	Present study	O'Donaghue, 2010	Williams et al., 2008; Logan et al., 2011	Harrington et al 2018
Refractive error				
Myopia ≤-0.50DS	10.6%	2.8 to 17.7%	9.4% to 29.4%	3.3% to 19.9%
Hyperopia ≥+2.00DS	24.4%	14.7 to 26%	5.4% to 12.3%	8.9% to 25%
Astigmatism ≥1.00DC	25.0%	25 to 29%		15.9 to 19.2%
Presenting visual acuity				
>0.3logMAR	6%	1.5 to 3.2%	0.6%	
≥0.3logMAR				3.4 to 3.7%
>0.5logMAR	2.5%			
Hypo-accommodation	12.7%	4.9%		
Manifest strabismus	15.5%			2.3%

Table 6.15. *Visual profiles of participants in the present study with other UK and Ireland studies examining typically developing children.*

The occurrence of hyperopia, myopia and astigmatism in a SpEN population in Northern Ireland is comparable with the refractive error reported in a SpEN population in Scotland (Das *et al.,* 2010). Das *et al.* (2010) and the present study determined refractive error by performing cycloplegic refraction. Woodhouse *et al.* (2014) and Donaldson *et al*. (2019) performed cycloplegic refraction in less than 9% of participants and therefore may be potentially under-estimating the prevalence of hyperopia and over-estimating the prevalence of myopia (Fotedar *et al.*, 2007; Morgan *et al.,* 2015). This is reflected in the data with Woodhouse *et al.* (2014) and Donaldson *et al.* (2019) reporting lower prevalences of hyperopia and higher prevalences of myopia compared to Das *et al.,* (2010) and the present study.

The prevalence of refractive error reported in a SpEN population in Northern Ireland is similar to the prevalence of refractive error reported in typically developing children in Northern Ireland (O'Donoghue *et al.,* 2010; O'Donoghue *et al.,* 2011). However, consistent with the literature, participants with Down syndrome and cerebral palsy presented with higher prevalences of hyperopia and astigmatism compared to typically developing children (Creavin *et al.,* 2009; Saunders *et al.,* 2010; Ghasia *et al.,* 2008). Similarly, participants with epilepsy presented with higher levels of hyperopia and astigmatism compared with their typically developing peers. This agrees with Gogate *et al.* (2011) who reported high prevalences of refractive error were also reported in children with epilepsy attending special education schools in India.

The prevalence of presenting visual impairment in the current study is considerably lower than the figures reported in England, Scotland and Wales (Donaldson *et al.,* 2019; Woodhouse *et al.,* 2014; Das *et al.,* 2010). This is likely due to the higher percentage of previous eyecare reported in the current study, 88.9%, compared with 55.8% in the Welsh study (Woodhouse *et al.,* 2014) and 56% in the English study (Donaldson *et al.,* 2019). The reported differences are also likely to be influenced by the type of children participating in the current study. The higher prevalence of visual impairment by Das *et al.* (2010) may be as a result of the participants being recruited from schools educating children with profound learning difficulties whereas the majority of participants in this study had learning difficulties ranging from moderate to severe. As discussed later in this chapter, an increase in the severity of a learning difficulty is associated with poorer presenting visual acuity and therefore it would be expected that a population of children with profound learning difficulties would have a higher prevalence of visual impairment compared to a population of children with moderate to severe learning difficulties. Although the prevalence of visual impairment is lower in the present study, it is ten times higher than the prevalence of visual impairment reported in typically developing children in England (Williams *et al.,* 2008) and two to four times higher than typically developing children in Northern Ireland (O'Donoghue *et al.,* 2010).

The prevalence of hypo-accommodation in the present study (12.7%) is similar to that reported by Donaldson *et al.* (2010) (10.6%) and Woodhouse *et al.* (2014) (14.3%). However, the prevalence is more than 2.5 times higher than reported by Ntodie (2019) for typically developing children in Northern Ireland (4.9%). As is consistent with the literature, participants with Down syndrome and cerebral palsy in the present study were more likely to present with abnormal accommodative accuracy (McClelland *et al.,* 2006; Nandakumar *et al.,* 2010; Stewart *et al.,* 2005; Watt *et al*., 2015; Woodhouse *et al.,* 2000; Woodhouse *et al.,* 1993).

The prevalence of nystagmus in the present study (4.5%) is identical to the figure reported by Das *et al.,* (2010) but lower than figures reported by Woodhouse *et al.* (2014) (9.8%) and higher than figures reported by Donaldson *et al.* (2010) (2.4%). This may be as a result of differing proportions of diagnoses within study populations i.e. conditions such as Down syndrome and cerebral palsy are associated with higher prevalences of nystagmus (Averbuch-Heller *et al;* 1999; Ljubic *et al*., 2011 Wagner *et al.,* 1990; Ghasia *et al.,* 2008). The full diagnosis profile of participants, however, is not presented by either Donaldson *et al.* (2019) or Woodhouse *et al.* (2014) and so the influence of Down syndrome and cerebral palsy on the prevalence of nystagmus within study populations cannot be determined.

A lower proportion of participants in the current study presented with manifest strabismus (15.5%) compared with that reported in England (22.6%), Wales (22.1%) and Scotland (17.5%). However, the percentage is over six times higher than the prevalence of manifest strabismus reported in typically developing children in England (2.3%). In a study examining a group of children with Down syndrome, the likelihood of one a child presenting with a manifest strabismus increased as the severity of the intellectual disability increased. A large proportion of the SpEN population have intellectual disability which may account for the higher prevalence of manifest strabismus compared to typically developing peers.

The occurrence of ocular abnormalities in the present study (9%) is considerably lower than the 50% reported by Woodhouse *et al*. (2010). Woodhouse's higher prevalence is likely to be due to investigators in the study using a hand-held slit lamp to examine ocular health, allowing for a more detailed evaluation of subtle anomalies such as blepharitis and Meibomian gland dysfunction, which wasn't used in the present study or in other studies. This is supported by lid and lash abnormalities accounting for over half of the ocular abnormalities recorded by Woodhouse *et al.* (2014). Das *et al.* (2010) also report a significantly lower prevalence of ocular abnormalities compared with the present study, Woodhouse *et al*. (2014) and Donaldson *et al*. (2019), however, lid abnormalities were not included in the list of abnormalities detailed by Das *et al.* (2010).

Visual field defects are commonly associated with cerebral palsy. Fazzi *et al*. (2012) reported that a visual field defect was present in 35% of participants with diplegia and in 65% of participants hemiplegia. Likewise, in the present study, 60% of participants with cerebral palsy displayed a restriction in their visual field. Donaldson *et al.* (2019) report a similar prevalence of visual field defects within a SpEN population (2.4%) to the present study (2.1%). This may be a reflection of a similar representation of cerebral palsy or brain damage in the participant group in both studies, however details of participant diagnosis are not extensively described by Donaldson *et al*. (2019).

The prevalence of visual impairment, strabismus and hypo-accommodation is significantly higher in a SpEN population in Northern Ireland compared with typically developing children in the UK. Although the prevalence of visual impairment is significantly lower than figures reported in other SpEN populations in the UK, in is important to note that the prevalence of visual impairment may be higher in a population of children with an increased severity of learning difficulty, i.e. profound.

The current study is the first study to report the near visual acuity, contrast sensitivity and colour vision of children within a SpEN population in the UK.

6.4.2. The influence of participant characteristics on visual status

Gender

Female participants in the present study were more likely to present with poorer acuity at both distance and near. O'Donoghue *et al.* (2010) found that typically developing females aged 12-13 years old in Northern Ireland also had significantly poorer presenting acuity compared to males, however no significant difference gender differences were found in the 6-7 year old age group. Conversely, Harrington *et al*. (2018) report no significant difference between genders in the presenting visual acuity of Irish typically developing children in the 6-7 year old or 12-13 year old age groups. Similarly, Williams *et al*. (2008) report no statistical difference in the prevalence of visual impairment in English males and females aged 7 years old.

Female participants in the present study were more likely to present with a manifest strabismus compared with male participants. Conversely, a prevalence study of typically developing children in England reported no significant gender difference in those presenting with a manifest strabismus in a group of 7 year olds (Williams *et al.,* 2008). The higher prevalence of manifest strabismus and reduced acuity in females may be related to a higher proportion of females having severe or profound learning difficulties (41.6%) compared to males (32.9%).

Severity of learning difficulty

In the present study, participants with SLD were more likely to present with poorer PVA, poorer contrast sensitivity, and a manifest strabismus compared with children with MLD. Similar findings were reported by Nielsen *et al.* (2007a); children with a lower IQ (≤50) were more likely to present with a visual impairment and have reduced contrast sensitivity compared to children with a higher IQ (≤70). Using the WHO classification of learning difficulty (ICD-10) an IQ of ≤70 would equate to a learning difficulty that ranged from mild to profound and an IQ of ≤50 would equate to a learning difficulty ranging from moderate to profound.

Tuppurainen (1983), Merrick *et al.* (2001) and Akinci *et al*., (2008) agree with findings in the present study and report that the prevalence of manifest strabismus increases with the severity of intellectual disability.

Data from McClelland *et al*. (2006) demonstrated that in children with cerebral palsy, accommodative responses were poorer in children with more severe intellectual impairment. In the present study, participants with SLD were more likely to present with poorer accommodative responses compared to children with MLD. Although it is important to note the possibility of cross-contamination of the SLD category with diagnoses which are associated with poor accommodative function i.e. Down syndrome and cerebral palsy.

Down syndrome

In the present study participants with Down syndrome were more likely to present with poorer PVA, reduced contrast sensitivity, accommodative lag, and ocular deficits compared to other participants. Such findings are consistent with those reported in the literature (Courage *et al*., 1994; Courage *et al*., 1997; Woodhouse *et al.,* 1996; Cregg *et al.,* 2001; Creavin & Brown, 2009; Little *et al.,* 2013).

Cerebral Palsy

In agreement with other studies, participants with cerebral palsy were more likely to present with poorer near-PVA, poor accommodative responses and abnormal eye movements (Coasta *et al*., 2014; Dufresne *et al.,* 2014; Dutton *et al.,* 2012; Fazzi *et al*., 2012; Ghasia *et al*., 2008; Guzzetta, 2014; Lampe *et al,* 2014; McClelland *et al*., 2006; Saunders *et al.*, 2010)

Autism

In the present study participants with autism were more likely to present with uncorrected refractive error. This may be due to "tactile defensiveness" that has been reported in children with autism and may present as non-tolerance to spectacle wear (Goldsmith *et al.,* 2006).

Other diagnoses

Study participants with epilepsy were more likely to present with reduced near-PVA. Anti-epileptic drugs have been shown to produce adverse effects which impact on visual performance (Hilton *et al*., 2004) and may be a contributing factor to reducing near-PVA. Participants with a hearing impairment were more likely to present with poorer PVA and near-PVA. However, 40% of participants with a hearing impairment also had a diagnosis of either Down syndrome or cerebral palsy, both of which are associated with reduced acuity.

Participants with speech and language difficulties were more likely to present with poorer PVA although a higher proportion of participants with speech and language difficulties presented with an uncorrected refractive error which may account for the reduction in PVA.

6.5. Conclusion

The visual profile of children attending special schools in Northern Ireland is comparable to other regions in the UK in terms of refractive error, strabismus, hypo-accommodation, nystagmus and visual field defect. However, a lower prevalence of visual impairment was reported in the SpEN population in Northern Ireland compared to other studies in the UK and Ireland. This may due to the higher percentages of history of eyecare reported in Northern Ireland or due to the participant population type which had a lower proportion of participants with profound learning difficulties compared to other studies. This is the first study in the UK to report on the contrast sensitivity, near visual acuity and colour vision of a SpEN population.

Chapter 7: Unmet visual needs of children attending a special school in Northern Ireland and the impact of in-school eyecare

This chapter aims to determine whether implementation of a comprehensive in-school eyecare framework results in any measurable improvement in participants' visual status

7.1. Introduction

Unknown or unaccounted for visual deficits such as refractive issues, impaired visual acuity, reduced contrasted sensitivity, restricted peripheral vision, anomalous eye movements and poor visual health, can have serious implications on a child's education and quality of life.

Uncorrected refractive error is one of the leading causes of avoidable visual impairment in the world (World Health Organisation, 2018). Compliance with spectacle wear in children can often present as a challenge and has been reported by UK studies as being twice as poor within a special educational needs population (50% compliance) compared to a mainstream education population (76-77% compliance) (O'Donoghue *et al*., 2010; Woodhouse *et al*., 2014).

Shankar *et al*. (2007) reported that children aged 4-5 years old who presented with uncorrected hyperopia and associated reduced near acuity preformed significantly worse on a test of early literacy compared to age equivalent emmetropic children. Bruce *et al*. (2018) investigated the effect of spectacle compliance on early developing literacy and report that literacy potential increased when visual acuity was improved with the correction of refractive error. Nandakumar *et al.* (2011) assessed the reading ability of a group of children with reduced accommodation five months before and five months after the accommodative deficit was addressed by the wearing of bifocal spectacles. Reading performance significantly improved when bifocals were successfully worn.

Uncorrected refractive error, along with amblyopia and ocular pathology, have been reported to be the principal causes of reduced visual acuity in children (Steinkuller *et al.,* 1999). The importance of visual acuity in a school environment was demonstrated by Chen *et al*. (2011). They examined the relationship between visual status and academic achievement and report that children with reduced visual acuity were more likely to exhibit low academic scores. Cox *et al.* (2001) recommend that children with reduced visual acuity should have school materials enlarged and be positioned in the classroom in such a way that they have an unobstructed view, i.e. close to and directly in front of the board. Farmer *et al*. (2007) demonstrated that the reading speed rate in children with low vision increased when large-print text was provided.

Anomalous eye movements have also been reported to impact children's academic-behaviour. Simons & Grisham (1987) and Rouse *et al.* (2009) report that children with symptomatic convergence insufficiency exhibit more difficulty reading than other children. Parent-reported academic behaviour surveys also indicated higher frequencies of problem behaviours displayed by children with symptomatic convergence insufficiency when performing schoolwork, including difficulty completing the task, avoidance and inattention (Simons & Grisham, 1987; Rouse *et al*., 2009). Orthoptic exercises are routinely recommended by eyecare professionals to improve convergence however intensive "office-based therapy" has been shown to be the most effective (Scheiman *et al.,* 2009, Adler, 2002)

Important aspects of visual function which have received less attention are peripheral vision and contrast sensitivity. These are vital visual components for mobility, particularly in the navigation of stairs and unfamiliar environments (Falkenberg & Bex 2005; Elliott *et al.,* 1990; Bittner *et al.,* 2011; Milling *et al.,* 2015). A deficiency in peripheral vision and/or contrast sensitivity can therefore increase the risk of falls (Dhital *et al.,* 2010). Contrast sensitivity is also important for children's social interactions, eating and learning as it can affect the ability to recognise faces and social cues (Elliott *et al.,* 1990), find food on a plate or read words on a screen if both are similar in colour e.g. mashed potato on a white plate or dark blue writing on a navy screen. Learning or communication materials presented in a high contrast format e.g. black writing/images on a white background and marking the edges of steps can improve access to education and mobility (Farmer *et al.,* 2007).

If the presence of any of the aforementioned visual problems are not accounted for, they can compound an already existing learning difficulty and may act as a further barrier to children in special education settings accessing learning opportunities.

7.1.1. Aims

This chapter aims to investigate the measurable impact of a comprehensive in-school eyecare model (collaboratively designed by key eyecare stakeholders and charities in the UK) on participants' visual status and visual need.

7.1.2. Objectives

i) Describe the unmet visual needs within a SpEN population with no current in-school eyecare service

ii) Determine whether participants' unmet visual need and visual status changes following the implementation of a comprehensive in-school eyecare model

iii) Identify predictive indicators of unmet visual need at baseline and follow-up

7.2. Methods

An '**unmet visual need'** was identified in instances where a visual deficit was unknown and/or not addressed by the participants' parent or teacher. Six unmet needs were identified and defined in Chapter 5 and include:

- Refractive issues (Refractive error and/or hypo-accommodation)
- Reduced contrast sensitivity
- Reduced acuity at distance and/or near
- Ocular deficit
- Visual field defect
- Anomalous eye movement and control (including strabismus)

Written reports were tailored to maximise each participant's visual potential and included recommendations for spectacle wear, secondary referral and environmental modifications to account for unmet needs if required. Table 7. demonstrates examples of such modifications.

Unmet visual need	Examples of environmental modifications/ strategies included in written report.
Reduced acuity	*Tom's vision is reduced compared to other children his age. Wearing glasses will not improve this so Tom needs to get closer to things, or they need to be made larger for him to see them as well as his peers. A rule of thumb for someone with his level of vision is that objects need to be 3x larger or he needs to be 3x closer to them to see them as well as someone with 'normal' vision. School/play material may need to be made bigger for him to easily see it. We have included examples of the size of Picture Exchange Communications (PECs) that he can easily see at different distances as a guide for you.*
Reduced Contrast sensitivity	*Alice doesn't see low contrast objects well making it hard for her to see things if they are faded or of similar colour or shade to their background. Good lighting will help. Reading and writing materials need to be simple, preferably black on white. Alice should use a soft, dark pencil (e.g. 8B) or black marker pen to write/draw. Plain, strong coloured toys/plates/games on unpatterned pale backgrounds will be more visible to her.*
Visual field defect	*Patrick does not see objects on his right-hand side without moving his head. This must be considered when feeding/positioning education and play items/positioning him in the classroom etc.*
Anomalous eye movement control	*Jason's eyes struggled to track our lights moving from side to side. This may make it difficult for him to read a book easily. He may need extra time to do this. Using a ruler, or another sheet of paper to cover text which is not being read may reduce other distracting information and help Jason to keep his place when reading.*

Table 7. *Examples of advice and modifications recommended for identified unmet needs*

7.2.3. Statistical analysis

Data were anonymised and entered into statistical package SPSS V.25. Chi-squared tests were used to evaluate differences between groups of participants demonstrating dichotomous traits at baseline and then again at follow-up. Logistic regression analyses were performed to assess the impact of independent variables on the likelihood that participants would present with unmet visual need at baseline and follow-up assessment. McNemar's test was used to evaluate the differences in the number of participants demonstrating dichotomous traits at baseline compared with follow-up. Changes in paired metrics (non-parametric distributions) were evaluated using Wilcoxon signed ranked test.

7.3. Results

One participant withdrew from the study after the baseline assessment therefore follow-up measures were possible for 99.5% (n=199) participants.

7.3.1. Visual deficits at baseline

One hundred and four participants presented with one or more visual deficits at baseline. Refractive issues accounted for the majority of visual deficits. Table 7.1. illustrates the distribution of visual deficits.

Visual deficit	Number of participants (%)
Refractive issues	Total= 76 (38.0%)
	Refractive error deficit= 63 (31.5%)
	Reduced accommodative accuracy= 45 (23.2%)
Reduced contrast sensitivity	24 (12.0%)
Reduced acuity at distance and/or near	17 (8.5%)
Ocular deficit	18 (9.0%)
Visual field deficit	4 (2.0%)
Anomalous eye movement control	53 (26.5%)

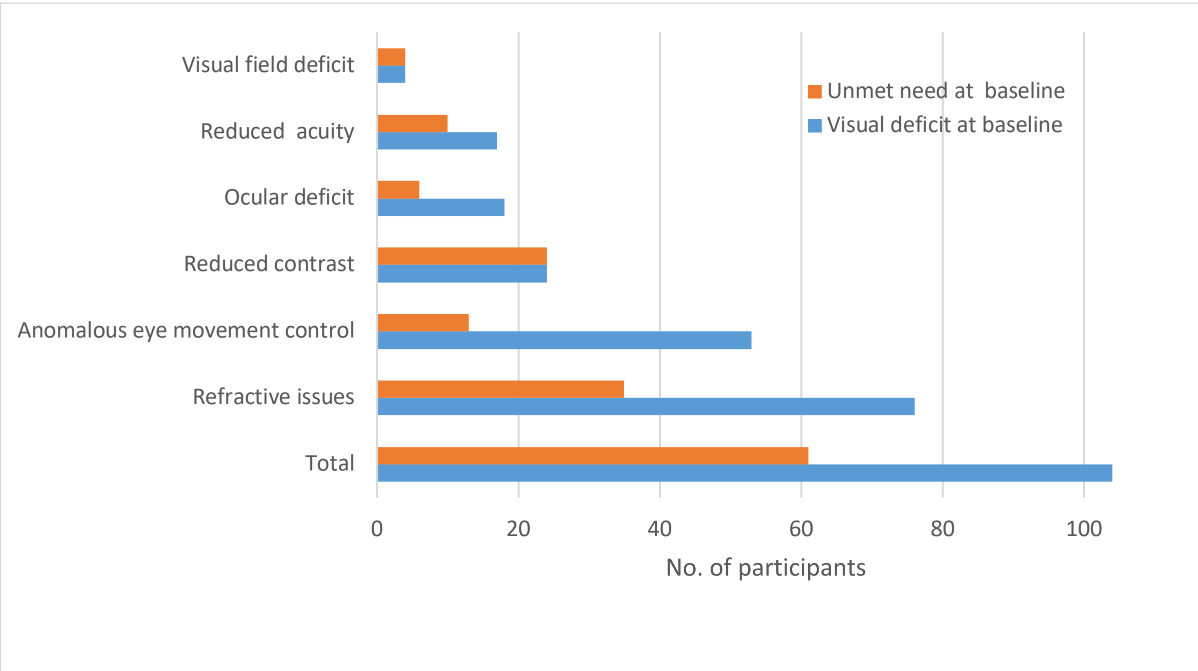
Table 7.1. *Visual deficits of participants*

7.3.2. Unmet visual need at baseline

Sixty-one (58.7%) participants with a visual deficit were identified as having one or more unmet visual needs at baseline; 38 (36.5%) participants had one, 15 (14.4%) participants had two unmet needs and eight (7.7%) had three unmet visual needs. Fifty-three (26.5%) participants required environmental modifications at home or school.

A history of eyecare was reported for 91.8% (56/61) of participants with an unmet need at baseline and for 80.6% (112/130) of those without an unmet need at baseline.

Graph 7. shows the number of participants presenting with visual deficits compared to the corresponding unmet visual need.



Graph 7. *Visual deficits and unmet visual needs of participants at baseline. N.B. participants may be included in one or more category.*

Visual field and contrast sensitivity deficits were all classified as constituting an unmet need as none were compensated for or recognised by teacher/parent report at baseline. Refractive issues were both the most common type of visual deficit and the most common unmet visual need at baseline.

7.3.3. Relation between unmet need at baseline and participant characteristics

Chi-squared tests were used to determine the presence of significant associations between participant gender/age/learning difficulty/diagnosis and unmet visual need status at baseline. Table 7.2. summaries analyses outcomes.

		Did the participant present with one or more unmet visual needs at baseline?			
		No (n=139)	**Yes (n=61)**	**Chi-squared test**	**p value**
Gender	Female	28.8% (n=40)	32.8% (n=20)	Yate's correction for continuity	p=0.688
	Male	71.2% (n=99)	67.2% (n=41)		
Education level	Primary	46.0% (n=64)	68.9% (n=42)	Yate's correction for continuity	$\chi^2[1]= 7.963$ **p=0.005**
	Post-primary	54.0% (n=75)	31.3% (n=19)		
Learning difficulty	SLD	33.3% (n=41)	52.8% (n=28)	Pearson	$\chi^2[2]= 7.613$ **p=0.022**
	MLD/SLD	14.6% (n=18)	17.0% (n=9)		
	MLD	52.0% (n=64)	30.2% (n=16)		
Autism	Yes	36.6% (n=45)	28.6% (n=16)	Yate's correction for continuity	p=0.380
	No	63.4% (n=78)	71.4% (n=40)		
Down Syndrome	Yes	5.4% (n=7)	20.0% (n=11)	Yate's correction for continuity	$\chi^2[1]= 7.809$ **p=0.005**
	No	94.6% (n=123)	80.0% (n=44)		
Cerebral Palsy	Yes	0% (n=0)	9.1% (n=5)	Fisher's exact test	**p=0.002**
	No	100% (n=130)	90.9% (n=50)		
Epilepsy	Yes	5.4% (n=7)	7.3% (n=4)	Fisher's exact test	p=0.735
	No	94.6% (n=123)	92.7% (n=51)		
Hearing impairment	Yes	1.5% (n=2)	5.5% (n=3)	Fisher's exact test	p=0.157
	No	98.5% (n=128)	94.5% (n=52)		
Speech and Language problems	Yes	63.1% (n=82)	74.5% (n=41)	Yate's correction for continuity	p=0.180
	No	36.9% (n=48)	25.5% (n=14)		

Table 7.2. *Associations between gender/age/learning difficulty/diagnosis and unmet visual need status at baseline.*

Statistically significant associations were found between education level (p=0.005), level of learning difficulty (p=0.022), a diagnosis of Down syndrome (p=0.005), a diagnosis of cerebral palsy (p=0.002) and the presence of unmet visual need at baseline. Participants educated to primary level, participants with SLD and participants with a diagnosis of Down syndrome or cerebral palsy were more likely to present with one or more unmet needs at baseline compared to other participants.

Direct logistic regression was performed to assess the impact of these factors on the likelihood that participants would present with unmet visual need at baseline. The model contained four predictor variables (age, level of learning difficulty, diagnosis of Down syndrome and diagnosis of cerebral palsy). The full model containing all predictors was statistically significant, χ^2 (5, n=176) =25.644, p<0.001. As shown in Table 7.3. only two of the independent variables made a unique statistically significant contribution to the model (age and a diagnosis of Down syndrome).

	B	**S.E.**	**Wald**	**df**	**p**	**Odds ratio**	**Lower 95%CI**	**Upper 95% CI**
Age	-0.101	0.044	5.282	1	**0.022**	0.903	0.829	0.985
Learning difficulty			3.210	2	0.201			
Down syndrome	1.388	0.555	6.259	1	**0.012**	4.006	1.351	11.880
Cerebral palsy	22.069	22527.6	0.000	1	0.999	3.989E+9	0.000	-
Constant	0.359	0.535	0.451	1	0.502	1.432		

Table 7.3. *Logistic regression assessing the impact of factors on the likelihood of presenting with an unmet need at baseline.*

Participants with a diagnosis of Down syndrome were 4 times more likely to present with an unmet visual need at baseline (Odds ratio= 4.006, 95% CI=1.351 to 11.880) and older participants were 0.9 times less likely to present with an unmet need at baseline assessment (Odds ratio= 0.903, CI=0.829 to 0.985).

7.3.4. Action/advice issued through the report

Table 7.4. summaries the actions/advice issued to participants' parents and teachers following the baseline eye examination.

Intervention		No. of participants
New prescription issued	Total	n=22
	Updated prescription	n=9
	First prescription	n=10
	Reading addition given	n=2
	Results forwarded to current eyecare provider	n=5
Encourage glasses wear advice		n=13
Reduced contrast sensitivity and increased contrast advice		n=24
Reduced vision enlarged print advice and adjusted seating position recommended		n=10
Onward referral to secondary care		n=4
Treatment advice given	Blepharitis advice	n=3
	NPC exercises recommended	n=7
Restricted visual field advice and adjusted seating position recommended		n=4
Reading advice for anomalous eye movements issued		n=2

Table 7.4. *Actions/ advice issued to parents and teachers following in-school eye examination*

7.3.5. Follow-up eye examination

Whilst the majority of participants had a follow-up eye examination performed over one visit (n=191), eight participants required two visits.

7.3.6. Feedback questionnaires

Parental feedback questionnaires were returned for 123 (61.5%) participants and teacher/classroom assistant questionnaires were returned for 90 (45.5%) of participants. Feedback questionnaires from a parent, teacher or both were available for 154 (77.0%) of participants.

7.3.7. Impact of in-school eyecare on unmet visual need and visual status at follow-up

Participant unmet visual need status was reassessed once follow-up measures were completed. Refractive issues were considered met when participants were wearing suitable spectacle correction. Unmet visual needs that required environment or learning material modifications (i.e. reduced acuity, reduced contrast, visual field defects and anomalous eye movements) were considered met where the parent and/or teacher employed the recommended strategies. Ocular deficit unmet needs were considered met when advice was given to treat the deficit or referral was made to secondary care.

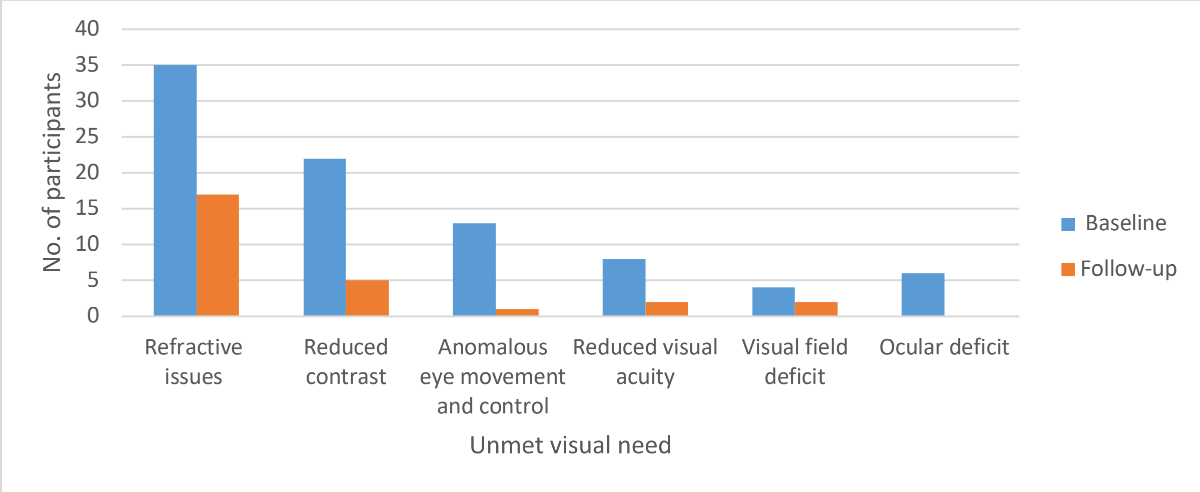
Parent and teacher feedback questionnaires remained outstanding for four participants who were recommended environment modifications, subsequently their unmet need visual status was unknown at follow-up. These participants have therefore been excluded from follow-up analysis.

McNemar's test was performed to determine if there was any change in the number of participants presenting with each unmet visual need prior to and following the provision of in-school eyecare.

Table 7.5. summaries the results from the analyses and Graph 7.1. illustrates the distribution of unmet visual need at baseline and follow-up assessment.

Unmet visual need		% of participants with an unmet visual deficit (n)	McNemar's chi-square test
Refractive issues	Baseline	17.5% (n=35)	**p<0.001**
	Follow-up (n=199)	8.5% (n=17)	
Reduced contrast sensitivity	Baseline	12.0% (n=24)	**p<0.001**
	Follow-up (n=197)	2.5% (n=5)	
Reduced acuity at distance and/or near	Baseline	5.0% (n=10)	**p=0.031**
	Follow-up (n=197)	1.0% (n=2)	
Ocular deficit	Baseline	3.0% (n=3)	**p=0.031**
	Follow-up (n=199)	0%	
Visual field deficit	Baseline	2.0% (n=4)	p=0.500
	Follow-up (n=199)	1.0% (n=2)	
Anomalous eye movement and control (including strabismus)	Baseline	6.5% (n=13)	**p<0.001**
	Follow-up (n=199)	0.5% (n=1)	
Total	Baseline	30.5% (n=61)	**p<0.001**
	Follow-up (n=195*)	10.3% (n=20)	

Table 7.5. *Unmet visual need at baseline and follow-up assessments. *N.B. four participants were excluded from analysis, due to lack of information on implementation of environmental modifications.*



Graph 7.1. *Distribution of unmet visual need at baseline and follow-up assessments*

The percentage of participants presenting with unmet visual need significantly reduced for all categories of unmet visual need, except the visual field category (McNemar, p=0.500). The overall percentage of participants presenting with unmet visual need significantly reduced from 30.5% to 10.3% following in-school eyecare (McNemar, p<0.001). The number of unmet visual needs that participants presented with at baseline significantly reduced from 92 to 27 following in-school eyecare (Wilcoxon signed rank test, z=-5.994, p<0.001, r=0.30). Refractive issues represented the greatest proportion (63.0%) of unresolved unmet need due to 17 participants who were non-compliant with spectacle wear.

7.3.8. The impact of spectacle wear on follow-up visual measures

The prescribing of spectacles was the primary intervention issued by the research team with the potential to alter visual status. Table 7.6. displays the outcomes from Wilcoxon signed rank tests performed on paired metrics of distance-PVA, near-PVA and accommodative effort for three groups:

i) Participants with **resolved** refractive issues

ii) Participants with **retained** refractive issues

iii) Participants with **no** refractive issues

		Resolved refractive issues at follow-up (n=17)	Retained refractive issues at follow-up (n=17)	No refractive issues at baseline (n=95)
Distance PVA (logMAR)	**Baseline Median (IQR)**	0.000 (-0.025 to 0.200)	0.200 (0.00 to 0.400)	-0.100 (-0.175 to 0.031)
	Follow-up Median (IQR)	0.000 (-0050 to 0.100)	0.300 (0.100 to 0.450)	-0.100 (-0.200 to 0.081)
	Wilcoxon signed rank test	*p=0.453*	*p=0.838*	*p=0.976*
Near PVA (logMAR)	**Baseline Median (IQR)**	**0.100 (0.025 to 0.263)**	0.088 (0.044 to 0.269)	0.000 (0.000 to 0.025)
	Follow-up Median (IQR)	**0.025 (0.00 to 0.131)**	0.138 (0.0188 to 0.400)	0.000 (0.000 to 0.025)
	Wilcoxon signed rank test	***z=-2.226, p=0.026 r=0.56***	*p=0.713*	*p=0.427*
Accommodative effort (D)	**Baseline Median (IQR)**	2.81 (2.50 to 3.25)	2.50 (2.02 to 3.32)	4.00 (4.00 to 4.00)
	Follow-up Median (IQR)	4.00 (2.87 to 4.00)	2.50 (2.00 to 2.72)	4.00 (4.00 to 4.00)
	Wilcoxon signed rank test	*p=0.114*	*p=0.878*	*p=0.099*

Table 7.6. *Baseline and follow-up visual measures of participants with resolved, retained and no refractive issues.*

Participants whose refractive deficits were corrected at follow-up displayed a statistically significant improvement in near-PVA (Wilcoxon signed rank test, p=0.026). Accommodative accuracy to a target placed at 25cm also improved in this group however the difference was not statistically significant (Wilcoxon signed rank test, p=0.114).

Both groups of participants with either no refractive issues at baseline or unresolved refractive issues at follow-up showed no change in distance PVA, near PVA or accommodative effort (Wilcoxon signed rank test, $p>0.05$).

There was no significant difference in SER of the left or right eyes of participants with retained or resolved refractive issues. (Mann-Whitney U= 131.00, p=0.658 and U=139.00, p = 0.865 respectively).

7.3.9. Relation between persistently poor spectacle compliance and participant characteristics

Chi-squared tests showed no significant association between spectacle compliance and gender (p=0.454), level of learning difficulty (p=0.296), Down syndrome (p=0.376), cerebral palsy (p=0.170), epilepsy (p=0.299), hearing impairment (p=1.000) or speech and language problems (p=0.402).

A statistically significant association was revealed between spectacle compliance a diagnosis of autism (Yates correction for continuity, $\chi^2[1]=6.195$, p=0.013). Direct logistic regression demonstrated that participants with autism were 4.5 times more likely to be non-compliant with spectacle wear (p=0.008, Odd ratio= 4.587, 95% CI= 1.502 to 14.084) than non-autistic peers.

7.3.10. Relation between persistent unmet visual need and participant characteristics

Chi-squared tests were performed to determine the presence of significant associations between participant gender/age/learning difficulty/diagnosis and retained unmet need at follow-up. Analysis outcomes can be viewed in Appendix 7.

Statistically significant association was found between the presence of unmet visual need at follow-up and a diagnosis of Down syndrome (p=0.019).

Direct logistic regression was performed to assess the impact of Down syndrome on the likelihood that unmet visual needs at baseline would remain at follow-up assessment. Participants with Down syndrome were eight times more likely to retain unmet need despite the in-school eye examination, in-school dispensing of spectacles and comprehensive reporting of visual needs (odds ratio= 8.077, 95% CI= 1.474 to 44.252). All participants with Down syndrome who had unmet visual need at follow-up assessment were non-compliant with spectacle wear.

7.4. Discussion

7.4.1. Unmet visual needs within a special needs' population

Sixty-one (30.5%) participants had an unmet need at baseline and yet the majority (91.8%) had a history of eyecare. Whilst a significant proportion (38%) of these unmet visual needs could be met with spectacle wear, the remainder (62%) required strategies to account for other important visual deficits. The requirement for spectacle correction is relatively easily explained and addressed (notwithstanding issues regarding compliance) by eyecare professionals, the high proportion of unmet visual needs in relation to other important visual deficits suggests that either identification of such deficits is poor and/or the communication of their presence and effective delivery of strategies to minimise their impact is limited. Such limitations may be particularly detrimental for children in special educational settings who already have challenges in accessing educational materials and learning.

The high percentage of a previous history of eyecare amongst those with an unmet need may also reflect the common difficulties eyecare professionals experience when examining children with intellectual disabilities, such as poor cooperation and difficulty in communication (Williams *et al*., 2014; Bowman, 2016; Li *et al*., 2015). In the present study eye examinations were performed in the school environment thus, providing the author with the opportunity to examine participants across more than one visit if required, hence increasing the likelihood of successful visual measures.

7.4.2. Impact of a comprehensive in-school framework on participants' visual status and visual need

The overall percentage of participants presenting with unmet visual need significantly reduced following in-school eyecare. A third of unmet visual need, however remained. The majority (37%) of residual unmet visual needs were due to environmental modifications not being implemented, whilst the remainder were attributed to non-compliance with spectacle wear.

Participants who wore spectacles following the identification of refractive issues at baseline displayed a statistically significant improvement in near-PVA at follow-up. Conversely participants who did not wear spectacles after being identified with refractive issues at baseline, showed no improvement in near-PVA. The importance of good near acuity in educational settings has been emphasised in the introduction to this chapter. Spectacle compliance is an essential component in removing refractive issues which may act as a barrier to children fully accessing their education.

The present study demonstrated that participants with autism were 4.5 times more likely to be non-compliant with spectacle wear compared to other participants. This is perhaps unsurprising as sensory difficulties, including tactile defensiveness, are commonly associated clinical features of autism. Tactile defensiveness can manifest as avoidance of being touched and apparent discomfort from wearing certain clothes (Kern *et al*., 2006; Baranek *et al.,* 1997) which suggests that wearing spectacles could also be a challenge.

7.4.3. Predictive indicators of unmet visual need

Participants with a diagnosis of Down syndrome were four times more likely to present with an unmet visual need at baseline and eight times more likely have their unmet need remain after implementation of the in-school eyecare framework.

It is widely reported in the literature that children with Down syndrome are at higher risk of blepharitis, keratoconus, cataract, optic nerve abnormalities (Creavin & Brown, 2010) in addition to amblyopia (Ljubic *et al.,* 2011) strabismus (Haugen *et al*., 2001) and refractive error (John *et al.,* 2004; Woodhouse *et al.,* 1997). It is therefore not unexpected that this group of children were more likely to present with unmet visual needs at baseline. Although Down syndrome is not a predictive indicator of poor spectacle compliance, all participants with Down syndrome in the present study who had retained unmet need at follow-up did not present wearing their spectacles, accounting for the majority of this group's retained unmet need (two participants also retained reduced contrast sensitivity as an unmet need and one participant retained reduced acuity as an unmet need).

7.5. Strengths

This is the **first** study to examine the impact of the recently designed in-school eyecare UK framework on visual status and unmet visual need of children in a special education setting.

7.6. Limitations

The pupil profile of the present school reflects primarily individuals with moderate and severe learning disability and may not be generalisable to children with profound or complex learning difficulties.

7.7. Conclusions

In-school eyecare with reporting significantly reduces unmet visual need in children with special educational needs. Additional work is required to develop strategies to encourage spectacle wear compliance, particularly in children with autism.

Chapter 8: Review of Statements of Educational Need

This chapter reviews Statements of Educational need at baseline assessment and one year later following the introduction of an in-school eyecare framework.

8.1. Introduction

When a child is identified as having special needs a Statement of Educational Need (SEN) is issued by the Education Authority. The SEN is a six-part document which identifies the child's educational, health and social needs and outlines the support and resources required from the school and other professionals to meet these needs (NI Government Services(b)). Each statement is reviewed by the Education Authority on an annual basis. Changes are made to the SEN if the child's needs have changed significantly or if the Education Authority decides that the child requires additional help or when the child has to move to a different school (NI Government Services(a)).

(Little & Saunders, 2015) examined the SEN and orthoptic records of a small sample of children (n=28) attending a special school located within the Western Trust in Northern Ireland. They reported that the majority of children with reduced vision and/or spectacle requirements did not have this information included on their statement.

8.1.1. Aims

i) Determine if visual deficits identified from the in-school baseline eye examination were described in the SEN.

ii) Explore if recommendations included within the written report issued as part of the in-school eyecare led to the SEN being amended.

8.2. Methods

Permission was sought from parents to access their child's SEN. The author examined each SEN for relevant visual and educational information to account for visual deficits identified in the baseline eye examination. Written reports issued to parents and teachers after the baseline visual examination indicated whether visual information should be included in the SEN. The SENs and annual reviews of participants, were re-examined for the inclusion of any new additional visual information twelve months later to allow time for the Education Authority annual reviews to take place.

Data were inputted into statistical package SPSS v.25 and anonymised.

8.3 Results

Permission was granted and SENs were accessed for 185 participants.

8.3.1. Baseline examination of SEN

104 children presented with one or more visual deficits at baseline. These visual deficits include:

- Reduced acuity at distance and/or near
- Refractive issues
- Reduced contrast sensitivity
- Anomalous eye movement and control problem
- Ocular deficit
- Visual field defect

SENs were available for review for 94 (90.4%) of these children. Twenty-five (26.6%) participants had at least one of their visual deficits recorded on their SEN. All three participants with a certification of visual impairment had this documented.

Table 8. outlines the number of participants presenting with each visual deficit and any corresponding information contained on the SEN describe the deficit.

Ocular deficit	SEN availability	Deficit reported in the SENs?	Details of any classroom modifications/advice included in SEN
Reduced distance and/or near acuity (n=17)	15/17	• 2/15 (13.3%) detailed a visual acuity measure • 3/15 (20.0%) advised that the child had reduced vision • 3/15 (20.0%) reported that the child is registered sight impaired • 2/15 (13.3%) recommended classroom modifications	*"take account of her visual difficulties- appropriate structured and learning environment"* *"minimise effect of visual impairment. Educational provision: advantageous seating position to account for visual difficulties."*
Refractive issues (n=76)	72/76	• 12/72 (16.7%) reported that the child needs to wear glasses	
Reduced contrast sensitivity (n=24)	22/24	No	
Anomalous eye movements and control (n=59)	48/53	• 14/53 (26.4%) reported the presence of a squint • 1/53 (1.9%) reported tracking problems • 4/53 (7.5%) reported the presence of nystagmus • 1/53 (1.9%) included advice regarding tracking issues	*"Unaware of left to right eye orientation for reading."*
Ocular deficit (n=18)	17/18	• 1/17 (5.9%) reported the presence of cataracts • 1/17 (5.9%) reported the presence of subluxated lenses • 1/17 (5.9%) reported the presence of ptosis	
Visual field deficit (n=4)	4/4	No	

Table 8. *Details of information and strategies included in SENs for visual deficits identified at baseline.*

8.3.2. Written report

It was recommended that the SEN should be amended for 79 participants to reflect the need for spectacle wear and/or classroom modifications to account for visual deficits identified in the in-school eye examination.

8.3.3. Re-examination of SEN

91.1% (72/79) SEN were available for re-examination twelve months later, all remained unchanged. A copy of the written report was included in the school file of sixteen (22.2%) participants. None of the annual reviews recommended amendments to the SEN following findings reported from the in-school eye examination.

8.4. Discussion

8.4.1. Baseline examination of SEN

In only 26.6% (25/94) of cases were at least one deficit reported in the SEN. None of the SENs recorded gross visual field deficits (affecting four participants) nor did any SEN reflect the contrast sensitivity deficits with which 23.4% (22/94) participants presented.

Table 8.1. demonstrates the reduced distance visual acuity and refractive error figures of the present study compared with data from Little *et al.* (2015).

Visual deficit	Little et al (2015)		SEE project	
	Presenting with visual deficit	Deficit recorded on SEN	Presenting with Visual deficit	Deficit recorded on SEN
Distance acuity ≥0.3	48.0% (12/25)	33.3% (4/12)	10.2% (19/185)	21.1% (4/19)
Significant refractive error. ≥+2.00DS ≤-0.50 ≥0.75	44% (11/25)	45.5% (5/11)	47.0% (87/185)	16.1% (14/87)

Table 8.1. *Comparison of reporting of visual deficits in SEN in Little et al., 2015 study and the present study.*

In both the present study and Little et. al study, all participants presenting with registrable levels of visual impairment had sight impairment registration recorded on their SEN. This is unsurprising as a medical diagnosis of sight impairment or severe sight impairment coupled with the pupil not making adequate academic progress are criteria for initiating a statutory assessment (Education Authority Northern Ireland, 2012).

Little *et. al,* (2015) reported a higher percentage of reduced vision (33.3%) and refractive error (45.5%) recorded on SENs compared with the current study (21.1% and 16.1% respectively). This disparity may be as a result of the differing in-school eyecare offered by the Western Trust compared with the Northern Trust as reported through the in-school survey detailed in Chapter 2. The school participating in the Little *et al*. study had orthoptic led in-school eye care compared to no in-school eyecare in the present study. Although the reporting rates within SENs are not optimal within the Little *et al.,* (2015) study, the regular presence of eyecare professionals in-school may have contributed to a higher percentage of visual deficits included in the SEN.

The most well reported visual deficit in the present study was strabismus where 14 SEN noted the presence of strabismus and 36 (19.5%) children in the present study had strabismus. The reporting of strabismus was not related to any functional impact this condition might have on the child's interaction with educational material.

Only 3.2% (3/94) of SEN provided commentary on how a child's visual function might be optimised to aid them accessing learning materials. Such information would have been beneficial for at least half (49/94) of the children with significant visual issues with potential to reduce visual performance metrics (these 49 are children who require environmental modifications i.e. VA distance/ near, nystagmus, contrast, tracking, and VF defect).

The language used in the three SENs to describe classroom modifications was often vague; failing to tailor the information to the child's specific visual deficit. This may be due to paediatricians compiling and inserting information from other medical reports as opposed to paediatricians including visual information written by eyecare professionals specifically for SEN use. Such reporting needs to be understood by non-eyecare audience and include information that is practical and relevant to the child in the "real world" setting.

8.4.2. Re-examination of SEN 12 months later

Despite written reports with recommendations for amendments to be made to SENs issued to both parents and teachers, all statements remained unmodified.

A 2017 report from the Northern Ireland audit office states that approximately 80% of SENs remain unchanged following annual review. It is estimated that each annual review costs the education authority £350. The review process was reported by schools participating in the audit be "bureaucratic, time consuming and ineffective" (The

Comptroller and Auditor General, 2017) . In light of this, it is perhaps is no surprise that none of the SENs reflected updated information about visual function.

Feedback was obtained from representatives from the Education Authority at the SEE project stakeholder day on the 7th December 2018; whilst they praised the idea of the vision report, further engagement is required to make the connection between vision and modification of SEN.

Another consideration is that the vision report information may have been regarded as unimportant/irrelevant when the review process was undertaken. This was reflected in none of the annual reviews undertaken by the school endorsing amendment to SENs even when vison reported recommended to do so.

8.5. Conclusion

Others, as well as the author, are aware that children's visual function and other aspects of their development are maturing through the school years, however this study has shown the difficulties in amending a SEN once it has been created. The regular presence of eyecare professionals in-school could not only increase awareness of the importance of vision in education to teachers, but give teachers the opportunity to ask for advice to adapt their learning materials and classroom for a child with a visual deficit.

Chapter 9: Participant Case Studies

This chapter presents case studies of four SEE project participants who represent themes identified in the preceding chapters. All names have been changed to maintain anonymity.

9.1. Case Study 1: Patrick

9.1.1. Background

Patrick is a five year old boy with global developmental delay, autism, severe learning difficulties and a diagnosis of Down syndrome. He has limited verbal skills but uses Makaton to communicate.

9.1.2. Baseline parent vision questionnaire

Patrick had an eye examination at his local optometrist a few months before baseline assessment. According to Mum, the optometrist had queried a long-sighted prescription however no spectacles were prescribed at the time. Mum had no concerns regarding Patrick's vision.

9.1.3. Baseline teacher vision questionnaire

Patrick's teacher had no concerns about his vision.

9.1.4. Baseline vision assessment

Table 9. details the results from Patrick's baseline vision assessment. Patrick is hyperopic but also has a significant astigmatic refractive error and poor accommodative accuracy. His vision is reduced for his age however this is likely to be a result of the uncorrected refractive error.

Measure	**Test**	**Result**
Visual acuity	Cardiff acuity cards @ 1m	6/9.5 binocularly, no cooperation for monocular measurement
Refractive error	Cycloplegia 1%	R: +2.00/-2.25x180 L: +1.75/-3.50 x 10
Accommodative accuracy	Dynamic retinoscopy	Significant lag to a target at 25cm in both eyes (unaided)
Ocular alignment and eye movements	Ocular motility, cover test	No manifest strabismus at distance or near to target. Ocular motility grossly full and smooth
Visual field	Gross confrontation	Full and symmetrical
Ocular examination	Direct ophthalmoscopy	External eye healthy R&L; media clear R&L; healthy disc R&L, CD ratio R: 0.5, L: 0.45; healthy fundi; normal maculae; normal blood vessels R&L.
Stereopsis	Frisby	Attempted but no engagement
Colour vision	CVTME	All plates correctly identified, no colour vision deficit.

Table 9. *Results from Patrick's baseline visual assessment*

Patrick was dispensed with single vision spectacles and both his mum and teacher were advised that he should wear his spectacles full-time.

9.1.5. Follow-up assessment

Patrick presented to the follow-up assessment wearing his spectacles. His visual acuity improved from 6/9.5 to 6/6 binocularly; monocular measurements were also possible (R=6/6, L=6/6). A significant accommodative lag was present in both eyes with Patrick's single vision spectacles. As spectacle compliance had been established, bifocals were dispensed. Accommodation was reassessed when Patrick collected his new spectacles and was determined to be accurate in both eyes through the bifocal portion of his glasses.

9.1.6. Parental feedback

Mum commented,

"I would like to extend my heartfelt thanks and appreciation to the SEE project as it greatly helped my child in determining a visual concern. The immediate intervention carried out has improved his vision and wellbeing."

9.1.7. Teacher feedback

At the follow-up assessment, the teacher mentioned that Patrick had misplaced his bifocal glasses for a few days. During the time that Patrick was awaiting the replacement pair the teacher noted that *"he wasn't doing the work that he was able to do previously with his glasses"*.

9.1.8. Discussion

As discussed in Chapter 4, a child with similar needs to Patrick, can often present as a challenge for practitioners due to communication and cooperation difficulties (McKillop, 2008; Bowman, 2016; Li *et al*., 2015) . These difficulties along with an unfamiliar environment and perhaps a lack of experience, may have contributed to Patrick's significant prescription remaining uncorrected at his first eye examination. However, in the right environment, with the appropriate equipment, experience and communication skills, the author was able to conduct Patrick's eye examination with relative ease.

If Patrick had not had an in-school eye test, his significant refractive error may have remained uncorrected and his learning potential may have been inhibited as suggested by feedback from his teacher.

9.2. Case Study 2: John

9.2.1. Background

John is a five year old boy with a diagnosis of Trisomy 21 Down syndrome and severe learning difficulties.

9.2.2. Baseline parent vision questionnaire

Mum reported that John had a significantly hyperopic and astigmatic refractive error and regularly attends the hospital for his eyecare. Mum stated that although John wore his spectacles well as a toddler, he now no longer tolerates them on his face. Mum is aware the lack of spectacle wear results in John having reduced vision. She is concerned that John's poor vision is affecting his development noting that he falls regularly and has trouble inserting shapes into shape sorters.

Mum stated that John finds the eye test at the hospital very distressing. During one visit John's cooperation was poor and he had to be restrained in order to insert the cycloplegic drops. She found this experience to be upsetting for not only John, but everyone involved.

9.2.3. Baseline teacher vision questionnaire

John's teacher was aware that he had spectacles but had issues with compliance. She was unaware that John's vision was poor without his spectacles and had previously made no modifications to his learning materials to accommodate this.

9.2.4. Baseline vision assessment

The author performed John's examination in the sensory room located beside his classroom as the teacher advised that this was the place in which John was most relaxed. John complied for the majority of the tests and cycloplegic drops were successfully instilled. Table 9.1. summaries the findings from the eye examination.

Measure	**Test**	**Result**
Visual acuity	Cardiff acuity cards @ 1m	6/48 binocularly (*significantly reduced for age*), no cooperation for monocular measurement
Refractive error	Cycloplegia 1%	R: +6.00/-1.50x180 L: +6.00/-2.00 x 180
Accommodative accuracy	Dynamic retinoscopy	Significant lag to a target at 25cm in both eyes (unaided)
Ocular alignment and eye movements	Ocular motility, cover test	Manifest right esotropia at distance and near. Ocular motility grossly full.
Contrast sensitivity	Cardiff contrast cards	2.17 (46%)- *significantly reduced for age*
Visual field	Gross confrontation	Full and symmetrical
Ocular examination	Direct ophthalmoscopy	External eye healthy R&L; media clear R&L; healthy disc R&L; healthy fundi; normal maculae; normal blood vessels R&L.
Colour vision	CVTME	Unable to assess, no engagement

Table 9.1. *Findings from John's baseline visual assessment.*

New, light spectacle frames that were adjusted for maximum comfort were dispensed to John and strategies were issued to both Mum and John's teacher to encourage John to wear his spectacles (Figure 9.). At Mum's request the author along with co-investigators visited John in his classroom on a weekly basis to monitor and further encourage spectacle wear.

Section 3 – Summary: The child's eyes and vision
John came to see us for his eye test today. He was quite distracted throughout the test, however we were able to get some measures of his vision. John is significantly longsighted with astigmatism, and has an inward turn in his right eye. The main concern with John is that he will not wear his glasses. His mum is concerned about how his vision is affecting his education and development, and is working with him at home to try and wear the glasses even for a short time each day. We have discussed methods to try and encourage glasses wear with his teacher, who will try and work with him at school to try and encourage John to wear his gasses. We have enclosed a leaflet which provides some strategies to try. This is also available as a video animation at the following link: https://www.youtube.com/watch?v=hUcvYm19NGQ.

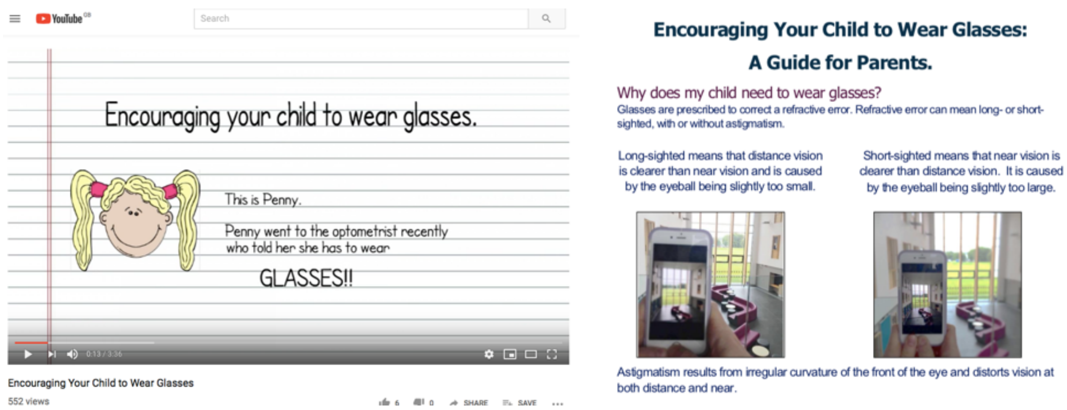


Figure 9. *Strategies issued to John's parents and teacher to encourage spectacle compliance.*

9.2.5. Follow-up assessment

Despite the efforts of Mum, John's teacher and weekly visits from the SEE project team over a four month period, John remained non-compliant with his spectacles and was at risk of developing bilateral amblyopia. The author consulted with John's hospital eyecare team and a decision was made to attempt to fit John with extended wear contact lenses to allow spectacle-free correction of his significant refractive error.

9.2.6. Parental feedback

Mum commented on her experience of the in-school eye examinations,

"The SEE project has been very beneficial to John, as I am frustrated with the NHS system. The SEE team recognise John's sensory problems and why he won't wear his glasses and have arranged a referral to explore other options for improving his vision."

A few months later Mum contacted the author with an update on John's progress:

"We have been going since September/ October time to see a specialist paediatric contact lens optometrist at the hospital. The contacts are a work in progress as he has been rubbing them out so we have been going every week but been getting a bit more success recently, best was when one stayed in for 22 days. I have learnt to put them in myself which is going great too! I feel it makes a big difference to him in activities and general life so thank you so much for the referral! If it wasn't for the SEE project we would have been going every three months to be told to persevere with glasses"

9.2.7. Feedback from the hospital

In May 2019 the author received a letter from the hospital contact lens clinic,

"It is most rewarding to have John's contact lens tolerance and visual behaviour improve over the last few months. It is also reassuring to hear that teaching staff are convinced that John is much more visually attentive and engaged when using the contact lenses"

An improvement in visual acuity was also reported being measured at 6/24 when previously 6/48.

9.2.8. Discussion

The value of having eyecare professionals in-school is demonstrated in this case study. This was the first opportunity for John to have an eye test performed in an environment in which he felt relaxed and comfortable. John was therefore able to cooperate with the eye examination eliminating the need for restraint and unnecessary upset.

The regular contact between the author, John's teacher and mum gave an insight into the challenges of improving spectacle compliance in a child with sensory issues. Such an opportunity is rarely experienced by eyecare professionals working in a clinical environment where patient contact is limited to three or six monthly intervals.

By recommending contact lenses as an alternative to the conventional treatment of spectacles (which had been unsuccessful even with perseverance), John’s vision is improving, reducing the risk of permanent visual impairment.

9.3. Case Study 3: Harry

9.3.1. Background

Harry is a seventeen-year old boy. He is non-verbal and has autism, epilepsy and profound learning difficulties.

9.3.2. Baseline parental vision questionnaire

Mum reported that Harry had never had an eye test as when she took him to the hospital, he became too distressed waiting to be taken through for his appointment, forcing them to leave. Mum was keen for Harry to participate in the study however commented that “Harry probably won’t understand what is going on and may find it stressful”.

9.3.3. Baseline teacher vision questionnaire

Harry’s teacher reported no concerns with Harry’s vision and was unaware of any problems.

9.3.4. Baseline vision assessment

Harry found it difficult to settle during his first baseline vision assessment visit. He continually paced the length of the room and wanted to leave, making visual measures impossible. A second visit was scheduled a week later. A few days before Harry’s second visit a co-investigator visited Harry’s teacher and noticed Harry sitting in the classroom calm and relaxed as he repeatedly watched the film trailer for “Mr Popper’s Penguins”. When Harry returned the next week for his second visit, the author uploaded the trailer to a tablet and used it as a fixation target. Harry instantly became calm and sat down in the chair. This enabled the author to perform binocular vision assessment, cycloplegic retinoscopy and ocular examination.

Harry was identified to be both myopic and astigmatic (R: -2.00/-1.25x 100 L: -2.25/-1.75 x 70). Spectacles were dispensed and fitted in school. Harry's one-to-one classroom assistant accompanied him when he came to collect his spectacles. After the author explained to the classroom assistant the benefits of spectacle wear for Harry she stated *"there's no point giving glasses to him, he's not going to wear them anyway."*

9.3.5. Parental feedback

Mum commented that she found the written report issued useful, *"it explained in detail his prescription and relevant needs"*. She stated that although Harry was *"still very resistant to wearing glasses, [she] would persevere"*. Recent feedback from Mum states that the length of time that Harry will keep his spectacles on for is steadily increasing and she hopes to eventually build him up to full-time wear.

9.3.6. Discussion

Harry is an example of a child who has great difficulty in communicating with those around him. Such difficulty can manifest as fear and frustration particularly when faced with unfamiliar situations. The regular presence of eyecare professionals in-school meant that Harry wasn't limited to one chance at his eye examination. The author was able to learn more about Harry before his second visit and establish techniques to increase the success of visual measures whilst minimising potential distress. The outcomes of which allowed Harry's mum to gain information about her son's visual capabilities and ocular health that were previously unknown.

The classroom assistant's negative comments unfortunately reflect an attitude that is commonly encountered when examining children with more complex and profound learning difficulties. Current policy within the UK promotes equality in healthcare for all (Equality Act, 2010; Special Educational Needs and Disability Act (Northern Ireland), 2016) . To deny a child the opportunity to improve their sight based on the assumption that their disability would prevent them from doing so or because it is viewed as being difficult to manage, is discriminatory.

9.4. Case Study 4: Bella

9.4.1. Background

Bella is a 6 year old girl with global developmental delay and severe learning difficulties. She is non-verbal and communicates using Makaton.

9.4.2. Baseline parental vision questionnaire

Mum reports that Bella attends the hospital for her eyecare and has no concerns regarding Bella's vision however she commented that *"Bella may find this process stressful. She has sat successfully for one test but not since".*

9.4.3. Baseline teacher vision questionnaire

Bella's teacher was unaware of Bella having vision problems and didn't raise any concerns.

9.4.4. Baseline vision assessment

Bella was examined across multiple visits as she was only able to maintain her attention for short periods of time. At her first visit Bella became agitated when the author came close to examine her eyes, resulting in Bella lashing out and spitting. At subsequent visits the classroom assistant returning with Bella, sang songs to soothe and calm her whilst the author examined her eyes.

Bella was found to have good vision and did not require spectacles however her contrast sensitivity was significantly reduced (12.5). Advice and strategies were recommended in the written report issued to parents and teacher (figure 9.1).

Bella had some difficulty seeing low contrast objects. This can mean that she has difficulty seeing objects if they are a similar colour or shade to the background. Good lighting will help with this. School work should preferably be black and white. Plain, strong colour objects will be more visible and easy to use.
Actions from today's test:
Modifications to classroom/ schoolwork needed to take into account Bella's difficulties seeing low contrast objects as detailed above.

Figure 9.1. *Advice and strategies issued to Bella's parent and teacher to address her reduced contrast sensitivity.*

9.4.5. Parental feedback

Mum reported that she found the written report useful in *"understanding Bella's limitations as we were not aware of this before"*. Regarding the strategies recommended to account for Bella's reduced contrast sensitivity Mum stated, *"we are more aware and will adapt accordingly when the need arises"*.

9.4.6. Teacher feedback

Bella's teacher reported that she *"found [the SEE project] to be a helpful and positive process. Particularly helpful as I teach children who are non-verbal and I was able to implement the findings into my daily routines/ adapt teaching where necessary"*.

9.4.7. Discussion

Reduced contrast sensitivity can not only affect a child's mobility but can also affect their ability to recognise faces (Elliott *et al.*, 1990) . For a child such as Bella who has difficulty in communicating this is particularly important.

Both parents and educators were initially unaware of Bella's visual deficit however when given the appropriate tools and information they were able to make adaptions to account for it. This case study shows the value in communicating useful and practical information to parents and teachers. Such information can remove barriers that may be preventing a child with an already existing learning difficulty from fully accessing their education.

Chapter 10 Thesis Discussion

10.1. Introduction

This is the first study to test the efficacy of an eyecare model which was collaboratively designed by key eyecare stakeholders and charities in the UK to promote equitable access to eyecare for children in special educational settings (The Royal College of Ophthalmologists, 2016). Visual status and unmet visual need were identified as key outcome measures. The study's definition of 'unmet visual need' was significant as it provided an outcome measure that was representative of the child's ability to perform daily activities. This was particularly important when visual status could not be improved but visual limitations could be reduced by adapting the child's environment.

This study, in addition, has bridged gaps in the literature by describing the in-school visual profile of children attending special education schools in Northern Ireland and the in-school eyecare services available.

10.2. Key findings

This study has exposed the extent of the inequity of in-school vision services offered by the different Health and Social Care Trusts to special schools in Northern Ireland. The inequity exists not only in terms of availability but also in the expertise of the professionals delivering services and the extent to which eye health and visual status are investigated and outcomes communicated to those involved in the child's care and education.

Unmet visual need significantly reduced and visual status improved following implementation of the comprehensive in-school eyecare model. Parental and teacher engagement was critical in significantly reducing unmet visual need by making the recommended environmental modifications and encouraging spectacle wear. However, a third of unmet visual need remained at follow-up and children with Down syndrome were more likely to retain their unmet visual need. Residual unmet visual need amongst the participant group was predominately attributed to non-compliance of spectacle wear.

Information and advice contained in the SEN of children identified as having reduced visual function was often missing or where present, was cluttered with clinical jargon unrelated to the child's educational needs/settings. Despite written reports being issued with advice and recommendations for amendments to SEN to address visual limitations, all SENs remained unchanged.

10.3. Limitations

The time period between baseline and follow-up ranged from two to five months. Whilst this allowed for school holidays and participant absences arising from sickness or other hospital appointments, it meant that some participants had less time to adapt to interventions such as spectacle wear. Residual unmet visual need may therefore be over-estimated in some instances.

Data from the present study were collected from one school and although participants were representative of Northern Ireland's special school population in terms of gender and age, they were not representative in terms of the severity of learning difficulty. Therefore, the outcomes may not be entirely generalisable to pupils with more profound impairments.

10.4. Discussion

The UK government has identified the need for better access to healthcare for children with SpEN and improved cooperation and sharing of information between healthcare and educational services (NHS England, 2019; Children and Young People (Scotland) Act, 2014; Children and Families Act, 2014; Special Educational Needs and Disability Act (Northern Ireland), 2016; Additional Learning Needs and Education Tribunal (Wales) Act, 2018). The importance of delivering care in the most appropriate setting, with minimal disruption to education, has also been recognised as an important component of paediatric health services (Department of Health, 2016; Department of Health 2010). However, this study has identified the inequity of in-school eyecare services currently available to children attending special education schools in Northern Ireland. Where in-school eyecare is available, it has been shown to lack routine key measures of visual function that are often found to be compromised in a SpEN population, i.e. refractive error, accommodation, contrast sensitivity and ocular health assessment (Nielsen *et al*., 2007; Das *et al.,* 2010; Pilling *et al.,* 2017; Kaur *et al.,* 2016; Puri *et al.,* 2015; Donaldson *et al.,* 2019; Woodhouse *et al.,* 2014; Gogri *et al.,* 2016).

Castle Tower school had no current in-school eyecare service, screening or otherwise, prior to the commencement of the study. It was therefore surprising that 87.9% of participants were reported by parents to have a history of eyecare, a figure which is significantly higher than the figures reported in other parts of the UK by Donaldson *et al.* (2019) and Woodhouse *et al.* (2014), (56% and 57.8% respectively). Nonetheless, 91.8% of participants with unmet need at baseline had a history of eyecare. A significant proportion of unmet visual need could be met with spectacle wear, but many required strategies to account for visual deficits, such as poor contrast sensitivity. This suggests that such deficits and their day-to-day impact had not been either assessed or effectively articulated to teachers or parents. Review of participants' SEN also demonstrated that such information had not been included.

The present study has shown that unmet visual need reduces, and visual status improves following implementation of a comprehensive in-school eyecare service. The outcomes of the present study support the inclusion of jargon-free reports describing visual strengths and weaknesses and highlighting actions required to address visual deficits, including environmental modifications, as a necessary component of visual assessments of children with SpEN. Without such reporting, the findings of the present study suggest visual deficits will remain unaddressed, to the detriment of the child's vision and learning opportunities.

Nevertheless, compliance with spectacle-wear remained an issue, particularly in children with autism and Down syndrome. The importance of correcting refractive error has been shown in the present study to improve near acuity and Bruce *et al.* (2018) demonstrated that literacy is associated with the level of visual acuity. Enhanced strategies and support are needed to encourage compliance with spectacle wear amongst children in special educational settings to promote optimal visual and learning outcomes.

Although over seventy participants with impaired visual function were issued with written reports which included recommendations for amendments to their SEN, all remained unchanged following review. There is therefore a risk that valuable information designed to address visual need is being lost when the child moves on to another class or changes school. Further engagement needs to be made with Teachers, the Education Authority and the professionals involved in compiling the SEN to improve the inclusion of such visual information or to discuss other methods of dissemination.

10.5. Recommendations for policy and practice

The following policy and practice changes are recommended in order to support teaching staff, parents and eyecare professionals in implementing a comprehensive in-school eyecare service at an organisational level and further reduce unmet visual need in a SpEN population.

10.5.1. Recommendations to support eyecare professionals deliver an in-school eyecare model

A training programme should be developed for professionals involved in delivering the eyecare model. The training should include:

i) Methods of adapting communication skills to verbal and non-verbal children e.g. a foundation course in Makaton, training in the use of the Picture Exchange System (PEC) etc.
ii) Techniques to adapt visual function measurements to suit the child's abilities.
iii) Strategies in how to to adapt the environment in order to account for visual limitations at home and in a school.
iv) Techniques to encourage compliance with spectacle wear.
v) Methods in writing jargon- free reports that describe a child's visual status and can be easily understood and interpreted by parents and non-eye care professionals

10.5.2. Recommendations to enable teachers and classroom assistants to support an in-school eyecare model

A training programme such as that designed by McClelland et al. (2018) should be further developed for teachers and classroom assistants. The training should include:

i) Information on how visual problems can impact on a child's ability to access learning materials and navigating the classroom environment.

ii) Methods in adapting the classroom and learning materials to address visual limitations

iii) Methods of improving spectacle wear in pupils e.g. starting up a glasses club e.g. "The Spectaculars" or having a reward chart for when glasses are being worn in class etc.

10.5.3. Recommendations to enable parents to support a child with visual problems support the service

An information evening should be offered to parents at schools before implementing an in-school eye care system. Information should include:

i) Common vision problems reported in children with special needs and how they be addressed/accounted for

ii) An introduction to the professionals that will be delivering the eyecare service and their role within the service

iii) Strategies to improve spectacle wear at home such as reward charts, or slowly building up the wearing time by encouraging the child to wear spectacles during activities that they enjoy.

10.6. Future directions

One important issue not addressed in the current study is the cost of implementing a comprehensive in-school eyecare service. The outcomes from a research study evaluating the cost of delivering such a service would provide crucial information to NHS service commissioners and the Education Authority.

The question of why SENs remained unchanged despite recommendations, is one that merits further research. Engagement is required with the education authority, teachers, educational psychologists and those responsible for compiling SENs to establish strategies for improving the visual information included in these statutory documents.

Despite spare pairs of spectacles being issued and strategies given to parents and teachers to improve spectacle wear, compliance remained an issue at follow-up. Cooperation with other professionals such as behaviourists and/or occupational therapists should be established to explore novel ways of improving rates of spectacle wear. A research study is required to identify the reasons for spectacle wear non-compliance in an SpEN population and to assess the impact of novel interventional strategies to improve compliance.

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Appendix 1 Ethical considerations and approval letters

Chapter 2.

There were few ethical implications of this research. School representatives were provided with participant information at the beginning of the questionnaire prior to providing any responses. The representative included information about their role within the school at the beginning of the survey. Any personal information received was linked anonymously with participants being given a unique identifier only known to the investigators. All data was held securely in line with the Data Protection Act 2018.

Chapter 4 and Chapter 5

Ethical implications were identified with regards to the recruitment of participants from a vulnerable group, confidentiality of participant data and the use of invasive procedures. The author and all other project investigators underwent Access NI checks and understood the 'Safeguarding Children' procedures. Consent was sought from parents of children aged under 18 and assent was sought from those aged 18 and over with the capacity to do so. Information sheets were issued to parents as well as to children in a child-friendly format (Appendix 3). A child could withdraw from the study at any time if they no longer wished to take part.

All subject data was anonymised and any personal information was kept in a locked filing cabinet in a secure office. All electronic information was held on a password protected computer. Data was held securely in line with the Data Protection Act 2018.

The procedure involving the use of cyclopentolate hydrochloride 1% eye drops to measure refractive error is commonly used in children in primary and secondary eyecare. Side effects of the drops include short-term blurred vision and pupil dilation which the parents and children are informed of prior to giving consen/assentt. Teachers were also advised on the side-effects of the drops. Disposable sunglasses and magnifying glasses were given to the children (when required) to minimise the impact of the temporary side-effects during the school day.

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Our Ref: NC:GOV

25 February 2016

Professor K Saunders
Room G151
School of Biomedical Sciences
Coleraine Campus

Dear Professor Saunders

Research Ethics Committee Application Number: REC/15/0125

Study Title: The Special Education Eyecare (SEE) project: Exploring the Impact on Visual Health of In-School Vision Care for Children in Special Education

Thank you for your recent response to matters raised by the committee. This has been considered and the decision of the committee is that the research should proceed.

Please also note the additional documentation relating to research governance and indemnity matters, including the requirements placed upon you as Chief Investigator.

The committee's decision is valid for a period of three years from today's date (this means that the study should be completed by that date). If you require this period to be extended, please contact the Research Governance section.

1. **Please complete and return the Chief Investigator Statement of Compliance prior to commencing the study and keep a copy for your file.**

2. **Please retain all other documents.**

Further details of the University's policy along with guidance notes, procedures, terms of reference and forms are available at the following web address:

http://research.ulster.ac.uk/office/rofficeeg.html

If you need any further information or clarification of any points, please do not hesitate to contact me.

Yours sincerely

Nick Curry
Senior Administrative Officer
Research Governance
028 9036 6629
n.curry@ulster.ac.uk

Memo

To: **Prof K Saunders, G151, Biomedical Sciences, CE**

From: Elaine McCormick, Research Governance, 1H12, JN

Date: 23 March 2016 **Ref:**

Dear Professor Saunders

Research Ethics Committee application number: REC/15/0125

Project Title: The Special Education Eyecare (SEE) project: Exploring the Impact on Visual Health of In-School Vision Care for Children in Special Education

Amendment Number: 1

Following submission of Amendment Number 1 for ethical approval, the Research Ethics Committee is pleased to confirm that the amendment should proceed.

The period for which the committee's decision is valid remains unchanged from the original approval.

If you need any further information please do not hesitate to contact me.

Thanks and best wishes.

Elaine McCormick
Admin Officer
Research Governance Section
Ext. 66518
e.mccormick@ulster.ac.uk

Ulster University

Memo

To: Prof K Saunders, G151, Biomedical Sciences, CE

From: Elaine McCormick, Research Governance, 26A17, JN

Date: 18 August 2016 **Ref:**

Dear Prof Saunders

Research Ethics Committee application number: REC/15/0125

Project Title: The Special Education Eyecare (SEE) project: Exploring the Impact on Visual Health of In-School Vision Care for Children in Special Education

Amendment Number: 3

Following submission of Amendment Number 3 for ethical approval, the Research Ethics Committee is pleased to confirm that the amendment should proceed.

The period for which the committee's decision is valid remains unchanged from the original approval.

If you need any further information please do not hesitate to contact me.

Thanks and best wishes.

Elaine McCormick
Admin Officer
Research Governance Section
Ext. 66518
e.mccormick@ulster.ac.uk

Appendix 2 School survey information pack.

Optometry and Vision Science
Research Group
School of Biomedical Sciences
Room I107
Ulster University
Cromore Road
Coleraine
BT52 1SA

The Special Education Eyecare (SEE) Project School Survey

School Principal letter of Invitation

Dear Principal,

You are invited to participate in The Special Education Eyecare (SEE) Project School Survey. All special educational schools in Northern Ireland are invited to participate to establish the current level of in-school vision care being provided.

The survey consists of 12 questions and will take approximately 3-4 minutes to complete. The majority of the questions are multiple-choice and ask for information about your school, other types of healthcare professionals that provide their services in your school and any current in-school visual assessment that is available for your pupils.

Based on the answers provided in the survey, your school may be re-contacted for the Special Education Eyecare (SEE) Project which is currently determining whether children in special education benefit from having their eyes tested while in school, rather than going to the hospital eye clinic or their local optician.

You will soon receive an email via the school email address with a link to the online survey. I would be grateful if you or the school's medical coordinator could complete the survey by the 1st March 2016.

Your input will be used to inform the SEE Project which is currently exploring the impact on visual health and classroom engagement of in-school vision care for children in special education.

If you have any questions regarding this survey, please email Shelley Black on black-s19@email.ulster.ac.uk or the chief investigator of this project Prof. Kathryn Saunders on kj.saunders@ulster.ac.uk.

Yours sincerely,

Prof. Kathryn Saunders and Mrs. Shelley Black

Chief Investigator Optometrist and PhD Student

Email invitation

Subject: The SEE Project School Survey

Dear Principal,

Further to the invitation letter sent on the 1st November, you or the school's medical coordinator are invited to participate in the Special Education Eyecare (SEE) Project School Survey. Your input will be used to inform the SEE Project which is currently exploring the impact on visual health of in-school vision care for children in special education.

The survey consists of 12 questions and will take 3-4 minutes to complete.

To complete the survey or for more information, please click the link below.

(link)

Completed surveys should be submitted by xxxxxxx

Yours sincerely,

Shelley Black

Ulster University

Optometrist and PhD student

Information Sheet

The aim of this survey is to establish what level of vision care is currently provided to children attending special education schools in Northern Ireland. Please take time to read the following information carefully before completing the survey.

Why have I been chosen?

You have been chosen as your school is a special education school in Northern Ireland.

Do I have to take part?

It is up to you to decide whether or not to take part. You can choose to take part by completing the enclosed survey after reading the study information and returning it in the stamped addressed envelope provided. You can also change your mind at any time and withdraw from the study without giving a reason.

What do I have to do?

You will be required to complete the questionnaire which should take approximately 3-4 minutes. There are 12 questions in total. Question 1 and 2 ask for details about you, the school and the healthcare professionals that provide services at the school. Questions 3 enquires about any current vision assessment that occurs within the school. Questions 4-10 are multiple choice and only require an answer if you answered 'yes' to question 3. If you answered 'no' or 'don't know' to question 3 you will be diverted to question 11. Question 11 is multiple choice and asks about how useful you feel regular vision checks are for children attending the school. Question 12 is multiple choice and enquires about the professionals that are available to pupils attending the school with a visual impairment.

Will my taking part in the survey be confidential?

Your responses will be linked anonymously, only the investigators will have access to unique identifying numbers. All data will be held securely and in line with the Data Protection Act 1998. Based on the responses your school may be re-contacted for the larger Special Education Eyecare (SEE) Project which is currently determining whether children in special education benefit from having their eyes tested while in school, rather than going to the hospital eye clinic or their local optician.

What will happen to the results?

The outcomes will be used to map out the current level of in-school vision care that is being offered to children attending special education schools across Northern Ireland. Your input will also be used to inform the SEE Project which is currently exploring the impact on visual health and classroom engagement of in-school vision care for children in special education.

Who has reviewed this study?

Ethical approval for the study has been obtained from the Ulster University School of Biomedical Sciences Ethics Filter Committee.

Contact Details:

If you have any questions about the survey, please contact us.

Study Coordinator: Shelley Black, black-s19@email.ulster.ac.uk

Chief Investigator: Professor Kathryn Saunders, kj.saunders@ulster.ac.uk

By completing the enclosed survey, you are giving your consent to take part.

Definitions

Optometrist

An optometrist is an eye health professional who examines eyes, tests sight and prescribes glasses when they are needed. Optometrists also give advice on visual problems and can detect eye diseases or other visual problems and refer patients to hospital eye clinics if needed.

Dispensing optician

A dispensing optician specialises in fitting and dispensing glasses.

Ophthalmologist

Ophthalmologists (eye surgeons) are doctors that specialise in the medical and surgical care of your eyes.

Orthoptist

Orthoptists are usually based in hospital eye departments and work with children and adults with eye conditions such as squints and lazy eyes.

1. Please give details about your school

Name of School	
Age range of pupils	
Address 1	
Address 2	
City/Town	
Your name	
Your position within the School	

2. Which healthcare professionals regularly work with the children at your school? (Please tick all that apply)

- ☐ School Nurse
- ☐ Community Paediatrician
- ☐ Speech and Language Therapist
- ☐ Behavioural Psychologist
- ☐ Physiotherapist
- ☐ Ophthalmologist
- ☐ Occupational Therapist
- ☐ Orthoptist
- ☐ Optometrist
- ☐ Other (Please specify) ______________________________

3. Do the children have their vision assessed in school?

- ☐ Yes (Continue to question 4)
- ☐ No (Skip to question 11)

☐ Don't Know (Skip to question 11)

4. Do the vision assessments require parental consent?

☐ Yes

☐ No

☐ Don't know

☐ Other (please specify)

____

5. What checks are normally involved in the vision assessment? (Please tick all that apply)

☐ A measure of what the child can see using a suitable chart

☐ Binocular assessment (i.e. check for lazy eye/squint)

☐ Internal eye health check (usually involves shinning a bright light into the eyes)

☐ Need for glasses assessment (usually involves the use of eye drops)

☐ Colour vision assessment

☐ Don't know

☐ Other (please specify)

____

6. Who usually carries out the vision assessment for the children? (Please tick all that apply, see introduction page for definitions)

☐ School Nurse

☐ Paediatrician

☐ Ophthalmologist

☐ Optometrist

☐ Orthoptist

☐ Don't Know

- ☐ Other (please specify)

  ____

7. Is there a report issued following the vision assessment for each child?

- ☐ Yes (Continue to question 8)
- ☐ No (Skip to question 10)
- ☐ Don't know (Skip to question 10)

8. Who normally receives a copy of the report after the vision assessment? (Please tick all that apply)

- ☐ Principal
- ☐ Teacher
- ☐ Classroom assistant
- ☐ School Nurse
- ☐ Parent/guardian
- ☐ Other (please specify)

  ____

9. If a child has been identified as having vision problems, does the report include recommended modifications that can be made either to the child's school work or to the classroom?

- ☐ Yes
- ☐ No
- ☐ I've never seen the report
- ☐ Don't know

Additional comments

____

10. In which Key Stage(s) does vision assessment take place? (Please tick

all that apply)

- ☐ Early Years Foundation Phase
- ☐ Key Stage 1
- ☐ Key Stage 2
- ☐ Key Stage 3
- ☐ Key Stage 4
- ☐ Key Stage 5
- ☐ Don’t Know

11. Do you think it is useful for children to have their vision checked regularly throughout their time at school?

- ☐ Yes
- ☐ No
- ☐ Don't Know

Please comment why____

12. Are any of the following eyecare professionals available at the school to provide support to pupils who may have a visual impairment? (Please tick all that apply)

- ☐ Qualified teacher of pupils with visual impairment (QTVI) from the local education authority
- ☐ Orthoptist
- ☐ Mobility/ rehabilitation specialist
- ☐ Don't know
- ☐ QTVI on school staff
- ☐ Optometrist
- ☐ Vision Support Teacher
- ☐ Other (please specify)

____

Appendix 3 SEE project information packs

The Special Education Eyecare (SEE) Project

School Principal letter of Invitation

Your school is invited to participate in The Special Education Eyecare (SEE) project. The aim of the SEE project is to determine whether children in special education benefit from having a full and comprehensive eye test in the familiar environment of their school, rather than going to the hospital eye clinic or their local optician. We are interested in finding out more about vision and visual health of children attending special education schools and how their vision interacts with classroom activities. It is partically important that children in special education get regular eye tests as a recent report from the UK charity SeeAbility has found children with learning difficulties are 28 times more likely to have serious sight problems than other children. This report also found that 37% of children in special education have never had an eye test.

Who are we?

The research team consists of:

Shelley Black: Shelley is a qualified optometrist and PhD student who has practiced within the community for the last eight years. She has also worked alongside the Kwale

District Eye centre in Kenya testing the eyes of children with special needs in their school.

Emma McConnell: Emma is an optometrist and research associate for this project. She has experience examining children both with and without special educational needs in community practice. She also has experience examining patients with visual impairment in a research setting.

Dr Lynne McKerr: Lynne is a researcher in the Centre for Behaviour Analysis at Queen's University. Trained as an anthropologist, she is also a qualified teacher who has worked with children with special needs and is the parent of a young adult with autism.

Dr Pamela Anketell: Pamela is an orthoptist based in Health and Social Care services. Pamela works with a range of children including those with and without special educational needs.

Prof. Karola Dillenburger: Karola is Professor of Behaviour Analysis and Education and Director of the Centre for Behaviour Analysis at QUB. She is a Clinical Psychology (HCPC) and Board Certified Behaviour Analyst-Doctoral (BCBA-D). She co-ordinates the MSc Autism Spectrum Disorders. Her research focusses on behavioural parent training and evidence-based interventions for people with autism and their families.

Associate Prof. A Jonathan Jackson: Jonathan is currently Head of Optometry at the Royal Victoria Hospital Belfast (BHSCT) and Chairs the Northern Ireland Translational

Research Group (Vision). His research interests include Low Vision, Paediatric Visual Impairment and Contact Lenses. He is passionate about interagency multi-professional clinics research.

Dr Julie-Anne Little: Julie-Anne is an optometrist and senior lecturer at University. She has several years experience providing vision care for children with and without special needs, including children with Down syndrome, autism spectrum disorder, and complex neurological disorders. She is keen to promote multidisciplinary working and communication through her research and clinical work.

Dr. Julie McClelland: Julie is an optometrist and lecturer at Ulster University. She is highly experienced in examining children both with and without complex neurological needs. Her previous studies have involved her working with children who have cerebral palsy, albinism and reading difficulties.

Prof. Kathryn Saunders: Kathryn is an optometrist and is the chief investigator of this project. She has many years experience providing vision care for children with and without special needs, including children with Down syndrome, cerebral palsy, complications of extreme premature birth and complex neurological disorders. She runs a paediatric and special needs clinic at Ulster University.

What will be required from the school?

If you agree to participate in the study we will supply printed information sheets for parents/guardians and the children along with consent forms that can be disturbuted via schoolbags. The information sheet can be provided in an electronic format which can be emailed to parents or put on the school website. We would also be happy to come into the school to give a talk to the children and/or parents about the project. When the children that are to be involved in the study are identified, their teachers will be given a questionnaire to help provide information on the child's visual skills and the presence and relevance of vision-related information in their Statement of Educational Need (SEN). Consent will be requested from parents to permit the researchers to access their child's SEN and the teacher's classroom notes.

With their consent, we will also contact parents directly to complete a number of questionnaires, similar to that of the teachers, to gather more information about their child's vision and behaviour. These questionnaires will be carried out by telephone, online or in paper form which will be returned to the school office and collected by a member of the research team.

A room which can be darkened will be necessary to carry out a comprehensive eye examination. The eye test is expected to last approximately 45 minutes and the child will receive this examination at an initial visit and again at a follow-up visit. The child's parents will be invited to attend the test, if they are unable to attend, the child's carer or classroom assistant will be invited to sit in with them.

A written report of the eye test and any provisions that can be made to help the child in school will be recorded. This report can be included in the child's statement of educational need.

To assess how vision affects classroom activities we hope to spend time with the child to see how they use their eyes and participate in the classroom. Two to five months after we first test the child we will repeat our tests to see if any of the measurements have changed.

After the follow-up visit teachers will be surveyed for feedback of the intervention.

Photos/Video

We would like to take photographs/videos of the children involved in the project to create an educational video/document about the SEE project. The video will be used to show other academics/teachers/parents/other children in special education what in-school eye testing involves. This video may be put on the University or school website. If parents do not wish their child to be photographed/videoed they will note this on the consent form.

What now?

If you consent to your school being part of the project please complete and return the consent form in the envelope provided and we will contact you to arrange a visit to your school.

If you would like any further information please contact Emma McConnell via email e.mcconnell@ulster.ac.uk or by telephone 028 7012 3650.

The Special Education Eyecare (SEE) Project

<u>School Permission form</u>

Name of Researchers: Shelley Black, Emma McConnell, Lynne McKerr, Karola Dillenburger Kathryn Saunders, Julie McClelland and Julie-Anne Little.

Name of school	
Address	
County / LEA	
Postcode	
Telephone number	
Email address	
Website	
Name of Head Teacher	
Name(s) of school nurse(s)	

Please confirm, by marking the boxes, that you agree with the following statements:

- I confirm that I have been given and have read and understood the research procedures for the study and have asked and received answers to any questions raised. □

- The school premises are permitted to be used for the examination of the children who are involved in the study both at the initial visit and follow-up. □

- The researchers are granted permission to have contact with the students involved in the study, and their teachers, on the school premises. □

Date: ………..………………..............

Signature…………………………….

Position………………………………

Please return via the envelope provided

The Special Education Eyecare (SEE) Project

Parent/Guardian Information Leaflet

What are we doing?

We are inviting your child to take part in a research study as he/she attends a school which provides Special Education. We are interested in finding out more about vision and visual health of children attending special education schools and how their vision interacts with classroom activities. Before you decide if your child can take part, it is important that you understand what the research is for and what your child will be asked to do. Please read the information sheet and do not hesitate to contact us to ask any questions about anything that might not be clear to you.

How may this research benefit your child?

This research may benefit your child directly as we will be examining your child's eye health and we can provide information on their vision and eye health for you and anyone else involved in the care of your child. If we find that there is something that needs to be done as a result of our examination, we can put actions in place to make sure this happens, e.g. providing glasses if needed. Our research will also help other children by providing them with eye health checks and our study will raise awareness about the importance of eye health checks for children amongst children, teachers and parents.

Thank you for taking the time to consider this invitation.

Background

A 2015 report from the charity SeeAbility estimates that within the general UK population, children with learning difficulties are 28 times more likely to have serious sight problems than other children and many children in special education have never had a full eye examination.

The aim of study is to find out more about vision and visual health of children in special education, how vision affects classroom activities and whether children in special education benefit from having their eyes tested in the familiar and convenient environment of their school.

Who are we?

Shelley Black: Shelley is a qualified optometrist and PhD student who has practiced within the community for the last eight years. She has also worked alongside the Kwale District Eye centre in Kenya testing the eyes of children with special needs in their school.

Emma McConnell: Emma is an optometrist and research associate for this project. She has experience examining children both with and without special educational needs in community practice. She also has experience examining patients with visual impairment in a research setting.

Dr Lynne McKerr: Lynne is a researcher in the Centre for Behaviour Analysis at Queen's University. Trained as an anthropologist, she is also a qualified teacher who has worked with children with special needs and is the parent of a young adult with autism.

Dr Pamela Anketell: Pamela is an orthoptist based in Health and Social Care services. Pamela works with a range of children including those with and without special educational needs.

Prof. Karola Dillenburger: Karola is Professor of Behaviour Analysis and Education and Director of the Centre for Behaviour Analysis at QUB. She is a Clinical Psychology (HCPC) and Board Certified Behaviour Analyst-Doctoral (BCBA-D). She co-ordinates the MSc Autism Spectrum Disorders. Her research focusses on behavioural parent training and evidence-based interventions for people with autism and their families.

Associate Prof. A Jonathan Jackson: Jonathan is currently Head of Optometry at the Royal Victoria Hospital Belfast (BHSCT) and Chairs the Northern Ireland Translational Research Group (Vision). His research interests include Low Vision, Paediatric Visual Impairment and Contact Lenses. He is passionate about interagency multi-professional clinics research.

Dr Julie-Anne Little: Julie-Anne is an optometrist and senior lecturer at University. She has several years' experience providing vision care for children with and without special needs, including children with Down syndrome, autism spectrum disorder, and complex neurological disorders. She is keen to promote multidisciplinary working and communication through her research and clinical work.

Dr. Julie McClelland: Julie is an optometrist and lecturer at Ulster University. She is highly experienced in examining children both with and without complex neurological needs. Her previous studies have involved her working with children who have cerebral palsy, albinism and reading difficulties.

Prof. Kathryn Saunders: Kathryn is an optometrist and is the chief investigator of this project. She has many years experience providing vision care for children with and without special needs, including children with Down syndrome, cerebral palsy, complications of extreme premature birth and complex neurological disorders. She runs a paediatric and special needs clinic at Ulster University.

What is involved?

Before we carry out any tests we will contact you soon after we receive your consent form to complete a Strengths and Difficulties questionnaire (SDQ) relating to your child. This should only take 5-10 minutes of your time. 4-6 weeks later we will contact you again (either by post or telephone) to repeat the SDQ and ask a number of questions to help us better understand your child's vision and behaviour e.g. do they bump into objects when they walk, have a history of tripping over things, are they easily distracted.

Then we will test your child's eyes in school during the school day. **We have special eye tests for children who can't read, talk, point or who have very limited attention. Even if a child can't do all the tests, we still want them to take part, and we will make sure they don't feel they have 'failed' the tests.** In addition, we will spend time with your child to see how they use their eyes and participate in the classroom.

Afterwards we will provide you with a written report describing our findings. We hope this will give you a better idea of how your child can see, what you can do to make the most of their vision and whether any further action is recommended e.g. information about vision problems included in the Statement of Educational Need. If you agree, we will also give a copy to other people involved in your child's care e.g. teacher, doctor, ophthalmologist etc. This report can be used to make sure that any visual problems your child has are taken into consideration by teachers and any therapists they see. Two to five months after we first test your child we will contact you again to repeat the SDQ a final time and then repeat our tests on your child to see if any of the measurements have changed.

We want to test at least 159 children's eyes across a range of ages and abilities.

This study has received ethical approval from the University of Ulster Research Ethics Committee.

It is up to you to decide whether or not to allow your child to take part. If you allow your child to take part, you will be given this information sheet to keep and be asked to sign a consent form. A simplified information sheet will also be provided which you can read with or to your child. If you decide your child may take part, you are still free to withdraw at any time and without giving a reason and without their rights being affected in any way.

What does the Eye Examination involve?

- We will assess how much your child can see. For some children this only involves the child looking at pictures while we observe their eye movements. Other children may match or name pictures or letters. We will try and measure what your child can see with both eyes open and what they see with each eye alone (using a patch or special glasses to cover one eye at a time).
- Eye movement testing will involve identifying if the eyes squint or turn in and how the eyes move in each direction. This involves your child looking at toys, pictures or a light for a short period of time.

- Where possible and appropriate your child's 3D depth perception will be tested using a simple 3D task that doesn't require any special glasses.
- We will also test, if appropriate, your child's ability to arrange simple 3D shapes to a given pattern.
- Your child's need for glasses will be measured. This will require drops being put into the eyes as this is the best, most accurate way of assessing the need for glasses in children. These drops are used routinely by eye care professionals to test children's eyes. The drops take 30 minutes to work. After 30 minutes we will shine a light into the eye to find out if there is a significant need for glasses.
- Finally, the health of your child's eyes will be examined by shining a light into the eyes for a short period of time. We will also take a photograph of the back of the eye.

N.B. If any previously unidentified eye anomaly is detected during the test process we will discuss the finding with you including advice on further management. If required, we may arrange a referral letter to the appropriate eye care professional with your permission.

Side Effects of Eye Drops

After having drops put in the eyes, most people find their vision is blurry when looking at things close to them. This lasts about 3-4 hours. The drops make the pupil of the eye larger and this means that bright lights can be uncomfortable for up to 24 hours. Children do not normally complain but they may be uncomfortable in bright sunlight.

Very rarely people experience facial flushing, dry mouth, increased heart rate and confusion after having these drops put in their eyes. These rare side effects only last a short time. We will monitor closely for any signs of side effects.

If your child has had a reaction to eye drops before, please let us know.

We have successfully used these drops in many previous studies in over a thousand children in mainstream and special education settings.

Ulster University Procedures

It is extremely unlikely that something will go wrong if your child takes part in the study. However, the University of Ulster has procedures in place for reporting, investigating, recording and handling adverse events and complaints from study volunteers. The University is insured for its staff and students to carry out research involving people. The University knows about this research project and has approved it. Any complaints will be taken seriously and should be made in the first instance to the Chief investigator, Professor Kathryn Saunders.

This study forms part of a postgraduate research fellowship funded by the Department for Employment and Learning.

Photos/Video

We would like to take photographs/videos of the children involved in the project to create an educational video/document about the SEE project. The video will be used to show other academics, teachers, parents and other children in special education what in-school eye testing involves. This video may be put on the University or school website. If you do not wish your child to be photographed/videoed please note this on the consent form.

What now?

If you consent to your child being involved in the study, please complete and return the enclosed consent form in to the school office and we will contact you regarding a time for your child's appointment.

If you would like more information regarding this study or have any concerns, please contact us:

Shelley Black: black-s19@email.ulster.ac.uk, 028 7012 3718, 07399783696

Emma McConnell: e.mcconnell@ulster.ac.uk, 028 7012 3650

Professor Kathryn Saunders: kj.saunders@ulster.ac.uk, 028 7012 3047

Dr Julie McClelland: jf.mclelland@ulster.ac.uk

Thank you for taking the time to consider this study.

The Special Education Eyecare (SEE) Project

Parent/Guardian Consent Form

Name of Researchers: Shelley Black, Emma McConnell, Lynne McKerr, Kathryn Saunders, Julie McClelland, Julie-Anne Little and Karola Dillenburger.

Parent/guardian name

Child's name

Date of Birth

Relationship to child

Contact details

Landline --------------------------------------

Mobile --------------------------------------

Email --------------------------------------

Home Address

The Special Education Eyecare (SEE) Project

Child Information Leaflet

Hi our names are Shelley and Emma, how do you do?

We're going to tell you what an Optometrist can do,

We look at your eyes and check what you see,

We want your eyes to be as good as they can be.

We'll chat to your mum and ask a question or two,

And find out what yours eyes can do.

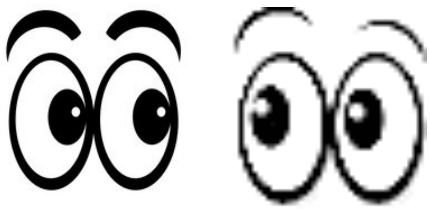
We are coming to school to see the girls and boys, We'll be checking their eyes with our lights and fun toys!!

Everyone gets funny glasses to wear,

They're light like a feather - you'll not know they're there.

We will look at your eyes as they follow our light,

So we know that you can look left and look right,



We will put in some drops that may sting a bit,

Then we'll sing a quick song, and you'll no longer feel it.

When the drops are all in you can have a rest,

For being so brave and for doing your best, Then after the rest we'll do some more checks -

You can look at our light, you can wear more cool specs.

We will see if you need spectacles of your own,

To see the TV, or your mum, or her phone!

Right at the end, two last things to do,

Shine a light in your eyes and take a photo, or two.

Then that is all and we'll write to your mum,

To tell her about all the things we have done

If you want us to look at your eyes

tick YES, YES I do,

If not, then say NO and that's ok too

✔Yes or ✗ No

Thank you for listening,

We hope our poem was cool,

And if you ticked 'YES' then we'll see you at school!

The Special Education Eyecare (SEE) Project

Young Adult Information Leaflet

Hi, our names our Shelley and Emma,

We would like to ask you to help us understand what you can see. If we can, we will try and help you see better. You do not have to take part if you do not want to. You can say Yes or No.

✔ Yes or ✗ No

For your eye check, we will ask you to look at letters or pictures

Sloan Letters Chart - 735000

LEA Symbols Chart - 250200

We will also get you to put on some glasses while you look at the letters and pictures.

We will get you to look at some 3D pictures and watch how your eyes move together.

We will check your eyes to see if they are healthy by shining a small light in your eyes.

For the last test we will need to put some drops in your eyes. The drops sting a little but this stops after a few seconds. The drops take 30 minutes to work while you have a break. The drops will make reading blurred.

When your break is finished we will shine a light in your eyes while you wear some glasses with changeable lenses in them to see if you need glasses of your own.

If we find that you need any extra help with your eyes we will tell you after your eyes have been checked. We will give your teacher, parent/guardian and doctors a written copy of the results of your eye check for their records.

We will come back within a few months to check your eyes again to see how you are getting on.

We would also like to take a photo or a video of some pupils having their eyes checked so that we can show other young people what it is like to have their eyes tested. Would this be ok?

As well as checking your eyes, we would like to speak to your parent/guardian, your teacher/ classroom assistant and your vision support worker (if you have one) about how well they think you can see. We will also ask your teacher to show me your classroom notes.

Thank you for looking at this information. If you would like us to test your eyes, or have any questions, please contact us by email or telephone.

Thank you,

Shelley and Emma

Shelley Black: black-s19@email.ulster.ac.uk, 028 7012371

Emma McConnell: e.mcconnell@ulster.ac.uk, 028 7012 3650

The Special Education Eyecare (SEE) Project
Young Adult Consent Form

Name of Researchers: Shelley Black, Emma McConnell, Lynne McKerr, Pamela Anketell, Karola Dillenburger, Julie-Anne Little, A. Jonathan Jackson, Julie McClelland, Julie McClelland and Kathryn Saunders.

Name

Date of Birth

Contact details		**Preferred contact?**
Landline	---------------------------------------	☐
Mobile	---------------------------------------	☐
Email	---------------------------------------	☐
Home Address		

Please confirm, by marking the boxes, that you agree with the following statements:

- I agree to take part in the above study. ☐
- I understand that my participation is voluntary and that I am free to withdraw at any time without giving a reason and without my rights being affected in any way. ☐
- I understand that if I do not take part in this research, this will not affect my routine eyecare. ☐
- I understand that the researchers will hold all information and data will be collected securely and in confidence and that all efforts will be made to ensure that I cannot be identified as a participant in the study (except as might be required by law) and I give my permission for the researchers to hold relevant personal data. ☐
- I consent for the researchers to access my Statement of Educational Need and my teacher's classroom notes. ☐
- I consent for the researchers to speak to my teacher/ classroom assistant about me. ☐
- I consent to in-classroom observation of my participation and learning. ☐
- I consent for the researchers to speak the vision support worker about me. ☐
- I consent that my image can be recorded on a photograph/ video and can be used by the researchers in educational videos and presentations. ☐
- I consent to receive follow-up advice or treatment as necessary due to any abnormalities detected during the study. ☐
- I give consent for a letter of information to be written to my GP or other health care professional involved in my care to inform them of the findings of my eye examination. ☐
- I confirm that I have been given and have read and understood the information sheet for the above study and have asked and received answers to any questions raised. ☐
- I consent to the research group contacting me about future studies, where appropriate. ☐

Signature________________________________

Date____________________________________

Please return via the envelope to the school office

Appendix 4 Baseline Questionnaires

Appendix 4: Baseline questionnaires

The Special Education Eyecare (SEE) Project
Questions for Parents/Guardians

Thank you for your participation in the study. Before we test your child's eyes we want to learn more about them so we can tailor the eye test to your child's needs. We have special eye tests for children who can't read, talk, point or who have very limited attention. Even if your child can't do all the tests, we still want them to take part, and we will make sure they don't feel they have 'failed' the tests.

The questions focus on five main areas:

1. Your child's current vision and any previous eye examinations they may have had
2. Your child's health and birth history
3. History of eye problems in your child's family
4. Your child's vision in relation to the world around them
5. Communicating with your child

We understand that you may not be able to, or may prefer not to, answer all the questions and that some of them may not apply to your child. Fill in the answers as best you can return to the school office or return it to Emma McConnell in the envelope provided.

If you would like more information you can contact us:

Emma McConnell: e.mcconnell@ulster.ac.uk, 028 7012 3650
Shelley Black: black-s19@email.ulster.ac.uk, 028 70123718, 07912502889
Professor Kathryn Saunders: kj.saunders@ulster.ac.uk
Dr. Julie McClelland: jf.mclelland@ulster.ac.uk
Dr. Julie-Anne Little: ja.little@ulser.ac.uk

Child's Initials: ____________ Child's ID:__________________________

Your child's details	
Name and address of your child's GP:	
Name and address of your child's paediatrician:	

Your child's eyes

Has your child ever had an eye test?

yes ☐ ✔ no ☐ ✖ don't know ☐ ?

Where did they last have their eyes tested?	
Date of last check:	
Date of next check:	

Does your child have any eye sight problems that you are aware of?

yes ☐ ✔ no ☐ ✖ don't know ☐ ?

If yes, please describe your child's vision problems as you understand them:

____

____

Do you have any concerns about your child's eyes?

yes ☐ ✔ no ☐ ✖ don't know ☐ ?

If yes, please provide details:

____

____

Does your child have glasses?

yes ☐ ✔ no ☐ ✖ don't know ☐ ?

If yes, are they worn:

Always / Sometimes / Rarely / supposed to but doesn't

Does your child have any problems with their glasses?

yes ☐ ✔ no ☐ ✖ don't know ☐ ?

If yes, please provide details: ______________________________

Do you ever see a turn in your child's eye?

yes ☐ ✔ no ☐ ✖ don't know ☐ ?

If yes, please provide details:

____

Does your child tend to shut one eye?

yes ☐ ✔ no ☐ ✖ don't know ☐ ?

If yes, which eye do they shut?

____

Does your child appear sensitive to bright lights?

yes ☐ ✔ no ☐ ✖ don't know ☐ ?

Visits to the Hospital

Has your child ever been to the eye clinic at the hospital?

yes ☐ ✔ no ☐ ✖ don't know ☐ ?

If yes, who did they see? *(Please circle)*

Ophthalmologist (eye doctor) / orthoptic clinic / hospital optometrist / low vision clinic

Please provide details:

____

____

____

Which hospital did they go to?	
Date of last appointment:	
Date of next appointment:	

Does your child wear a patch on their eye or have they in the past?

yes ☐ ✔ no ☐ ✖ don't know ☐ ?

If yes, please provide details *e.g. age your child wore the patch from and to, which eye etc.*

____

Has your child ever had an operation or surgery on their eyes?

yes ☐ ✔ no ☐ ✖ don't know ☐ ?

If yes, why?

____

Does your child have a Certificate of Visual Impairment?

yes ☐ ✔ no ☐ ✖ don't know ☐ ?

If yes, are they registered:

Severely sight impaired / sight impaired / not sure

Your child's family history

Is there a history of blastoma in your family?

yes ☐ ✔ no ☐ ✖ don't know ☐ ?

Has anyone in your child's family had eye problems?

yes ☐ ✔ no ☐ ✖ don't know ☐ ?

For example wears glasses, blastoma, squint, lazy eye, patching one eye, eye condition etc?

If yes, please write who has had problems and what problems they've had:

Who	What problem
e.g. sister, mum	*Has a lazy eye and glasses*

Your child's health

Does your child use a wheelchair?

yes ☐ ✔ no ☐ ✖ sometimes ☐

Does your child have a diagnosis of any medical conditions, syndromes or disabilities?

yes ☐ ✔ no ☐ ✖

If yes, please say what they are:

Does your child take any medication?

yes ☐ ✔ no ☐ ✖ don't know ☐ ?

If yes,

What is it called? How much do they take? What is it for?

____

____

____

Does your child have any allergies?

yes ☐ ✔ no ☐ ✖ don't know ☐ ?

If yes, please provide details:

____

Does your child complain of headaches?

yes ☐ ✔ no ☐ ✖ don't know ☐ ?

Is your child deaf or hard of hearing?

yes ☐ ✔ no ☐ ✖

If yes, please provide details:

____

Birth history

How many weeks into pregnancy was your child born? ________________

Were there any problems at the time of birth?
(i.e: mother having infection, prematurity, low birth weight, need for special care etc)

yes ☐ ✔ no ☐ ✖ don't know ☐ ?

If yes, please provide details:

____

____

Your child's communication

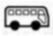
Does your child find it hard to communicate?

yes ☐ ✔ no ☐ ✖ sometimes ☐

What helps your child to communicate? Tell us if you use things like:

Makaton  yes ☐ ✔ no ☐ ✖

Yes/ no answers yes ☐ ✔ no ☐ ✖

Pictures  yes ☐ ✔ no ☐ ✖

Gestures yes ☐ ✔ no ☐ ✖

Other *(please describe how you communicate with your child):*

Your child's education and environment

Is there any information about your child's eyesight on their Statement of Educational Need?

yes ☐ ✔ no ☐ ✖ don't know ☐ ?

Does a vision support worker/ teacher visit your child while they are at school or at home?

yes ☐ ✔ no ☐ ✖ don't know ☐ ?

If yes, how often? ________________________________

Are you concerned about your child's eyesight and how it affects their education?

yes ☐ ✔ no ☐ ✖ don't know ☐ ?

If yes, please provide details:

____

____

Does your child get support from any vision charities or groups e.g. Angel Eyes, RNIB?

yes ☐ ✔ no ☐ ✖ don't know ☐ ?

If yes, please provide details:

____

Do you modify anything at home to help your child with their vision? *E.g. moving their chair closer to the television etc.*

yes ☐ ✔ no ☐ ✖ don't know ☐ ?

If yes, please provide details:

____

____

Five Key Questions

We would also like you to consider the following five questions. These questions are designed for a range of ages and abilities, so some questions may not be relevant. Your child may have difficulty with some behaviours listed below but not others – this is normal. You may also notice that some of the behaviours described occur only occasionally or more frequently when your child is tired - this is common.

Tick the box which best describes your child's current behaviour and if, for example, you child uses a wheelchair and the question involving stairs is not relevant, tick "not applicable".

1. Does your child have difficulty walking down stairs?

Never	Rarely	Sometimes	Often	Always	Not applicable

2. Does your child have difficulty seeing fast-moving objects?

Never	Rarely	Sometimes	Often	Always	Not applicable

3. Does your child have difficulty seeing something that is pointed out in the distance?

Never	Rarely	Sometimes	Often	Always	Not applicable

4. Does your child have difficulty locating an item of clothing in a pile of clothes?

Never	Rarely	Sometimes	Often	Always	Not applicable

5. Does your child find copying words or pictures time-consuming and difficult?

Never	Rarely	Sometimes	Often	Always	Not applicable

Please tell us any other information we may need to know that will help us test your child's eyes *e.g. if they have had an eye test before, is there anything they found difficult or stressful?*

____

____

____

The Special Education Eyecare (SEE) Project
Questions for Teachers

The parent/guardian of ___________________ has given their consent for their child to be part of this study. We would like you to answer the questions to help us learn more about this child's eyes.

We understand that you may not be able to answer all the questions and that some of them may not apply to this child. Fill in the answers as best you can and return them to the SEE Project post-box in the envelope provided.

If you would like more information you can contact us:

Shelley Black: black-s19@email.ulster.ac.uk
Emma McConnell: e.mcconnell@ulster.ac.uk, 028 7012 3650
Professor Kathryn Saunders: kj.saunders@ulster.ac.uk
Dr. Julie McClelland: jf.mclelland@ulster.ac.uk
Dr. Julie-Anne Little, ja.little@ulster.ac.uk

Questions for Teachers *(Please circle as appropriate)*

1. Does the child wear glasses? Yes / No / Not Sure

   If yes, are they worn: Always / Sometimes / Rarely / Supposed to but not

2. Is there any information about eye sight on the child's Statement of Educational Need?

   Yes / No / Not Sure

3. Does a Vision Support teacher or QTVI visit this child?

   Yes / No / Not Sure

   If yes, how often?

   ____

4. Does the child have any eye sight problems you are aware of?

   Yes / No / Not Sure

   If yes, please describe the child's eye sight problem(s) as you understand them

   ____
   ____
   ____
   ____

5. Do you know if the child has a Certificate of Visual Impairment?

   Yes they do / No they don't/ Not Sure

If they do are they registered as: Severely Sight Impaired / Sight Impaired / Not Sure

6. Do you modify anything in the classroom to help with the child with their vision? *E.g. desk wedge, large print reading materials, iPad etc.*

Yes / No

If yes, please describe these adjustments

Appendix 5 Written report templates

The SEE Project

A research study by Ulster University exploring visual health in Special Education.

Results of your child's research vision assessment

Thank you for allowing your child to take part in our research study. We hope the following information, gathered during the research, is useful. We have used the information you gave us about your child and the results we obtained when testing their eyes, to describe their vision.

Section 1 – Details of child	
Child's name and date of birth:	

Section 2 – Dates of the research eye test	
Date of this test:	Click here to enter a date.

Section 3 – Additional detail about the research eye test	
Where did the test take place and who was present?	
What was already known about eyes and vision? **Did anyone have questions about eyes and vision?**	

Section 4 – Assessors	
Whom is this report from? **Name:**	**Role:**
Address:	
Who is getting a copy of this report?	

Section 5 – Summary

ABOUT THE CHILD'S EYES AND VISION:

ACTIONS FROM TODAY'S TEST:

Glasses needed **NO**

Modifications to classroom / schoolwork needed **NO**

Statement of Educational Need should include information about vision needs	**NO**
Child is eligible for certification as visually impaired	**NO**
If yes, is certification in place?	*Choose an item*
GP action required	**NO**
Another specialist needs to see this child	**NO**

Section 6 – We tested to see if glasses are needed

We were able to test for glasses today **NO**
Glasses are needed **NO**

Why are glasses needed? **Choose an item**

We measured for focusing accuracy: **NO**

We gave a prescription for glasses: YES

RIGHT		Sph	Cyl	Axis	Prism	Sph	Cyl	Axis	Prism	LEFT
	Dist									
	Near									

See prescription above

What are these glasses for?

Choose an item

Section 7 – Results of the vision tests we did today

Visual acuity describes how well a person sees black on white detail with glasses if needed.

The vision results were:

Visual acuity for looking at things in the distance:

This was tested today: **NO**

Choose an item

Visual acuity for looking at things close up:

This was tested today: **NO**

Choose an item

We have included examples that this child should easily see:

Choose an item

Binocular vision and eye movements:
This is how well your child's eyes work together

This was tested today: Choose an item

Choose an item

Visual field:

This is how well your child can see things to the side of their central vision
This was tested today: **NO** **This is OK**
Contrast sensitivity: This is how well objects are seen against different backgrounds
This was tested today **NO** **This is OK**
Section 8 – Results of the eye health check
The health of the eyes – inside and out: This was checked today: **NO** **This is OK** The child needs to see another specialist about their eye health **NO**

Section 9 – Technical details from the research eye test results
Visual acuity:
Refractive error (with cycloplegia; 1% cyclopentolate):
Accommodative function (dynamic ret):
Ocular posture and eye movement assessment:
Visual field
Eye health exam

The SEE Project

A research study by Ulster University exploring visual health in Special Education.

Section 1 - Details of child	
Child's name	
D.O.B	
School	
Date of test	

Results of your child's research vision assessment

Thank you for allowing your child to take part in our research study. We hope the following information, gathered during the research, is useful. We have used the information you gave us about your child and the results we obtained when testing their eyes, to describe their vision.

Section 2 - Additional detail about the eye test	
Who was present at the eye test?	
What was already known about eyes and vision? Did anyone have questions about eyes and vision?	

Section 3 – Summary: The child's eyes and vision

Actions from today's test:	
Glasses needed	NO
Modifications to classroom/ schoolwork needed	NO
Statement of Educational Need should include information about vision needs	NO

Child is eligible for certification as visually impaired NO

GP Action required NO

Another specialist needs to see this child NO

Section 4 – We tested to see if glasses are needed

This was tested: Yes ☐ No ☐ This was difficult to assess today ☐

We measured for **focusing accuracy**:

This was tested: Yes ☐ No ☐ This was difficult to assess today ☐

Details:.

We gave a new prescription for glasses: Yes ☐ No ☐

Section 5 – Results of the vision tests we did today
Visual acuity: describes how well a person sees black on white detail with glasses if needed.
We were able to measure visual acuity for looking at things: in the distance ☐ close up ☐ both were difficult to test today ☐
Binocular vision and eye movements: This is how well your child's eyes work together
This was tested today: Yes ☐ No ☐ This was difficult to assess today ☐ **Details:**
Visual Field: This is how well your child can see things to the side of their central vision
This was tested today: Yes ☐ No ☐ This was difficult to assess today ☐ **Details:**
Contrast Sensitivity: This is how well objects are seen against different backgrounds
This was tested today: Yes ☐ No ☐ This was difficult to assess today ☐ **Details:**
Evidence of Cerebral Visual Impairment (CVI): This is when there are visual difficulties caused by problems in the brain rather than the eyes.
This was tested today: Yes ☐ No ☐ This was difficult to assess today ☐ **Details:**

Section 6 – Results of the eye health check		
This was tested today: Yes ☐ No ☐ This was difficult to assess today ☐ Does the child need to see another specialist about their eye health? Yes ☐ No ☐ **Details:**		
Section 7 – Technical details for other health professionals		
Visual Acuity	*LEA crowded LogMAR test at 3m (naming)*	
	LEA crowded LogMAR near test at 40cm	
Refractive Error	*With cycloplegia*	**R: L:**
Accommodative Function	*Dynamic retinoscopy*	
Ocular Posture and Eye Movement	*Ocular Motility, Cover Test*	
Contrast	*Cardiff Contrast Cards*	
Visual Field	*Gross confrontation*	
Eye Health Exam	*Direct ophthalmoscopy*	
Stereopsis	*Frisby*	
Colour Vision	*CVTME*	
CVI	*LEA Postbox and rectangles; shape sorter*	
Section 8: Assessors		
Whom is this report from? Name: Role: Address: Who is getting a copy of this report?		

Appendix 6 Feedback questionnaires

Evaluating In-School Vision Testing:

How was it for you?

Parent Questionnaire

We would like to thank you again for allowing your child to take part in The SEE Project. As you know, we have been offering in-school eye examinations to pupils in special educational schools as part of a research study. We hope that this research will be helpful in planning future eye care services for children in special education.

This is your chance to tell us what you think eye care services for children in special education should be like and to tell us what you think of the in-school eye examination your child had by filling in this short survey*. **We would be very***

grateful for your feedback, comments and suggestions. This questionnaire should take 5-10 minutes to complete.

By completing this questionnaire we are assuming that you are giving your consent to participate in this study, however you are free to withdraw at any time. Once completed please return the questionnaire to the school in the envelope provided.

Ethical approval has been granted by the Research Ethics Committee at Ulster University.

Child's initials ______ Child ID_____

1. How useful do you think the in-school eye test was for you, your child and school staff?

	Not at all useful	Somewhat useful	No strong opinion	Useful	Very useful
You	1	2	3	4	5
Your child	1	2	3	4	5
School staff	1	2	3	4	5

2. Please rate your experience of the following items regarding in-school eye tests:

1= very poor, 2= poor, 3= no strong opinion, 4= good, 5 = very good, 6=don't know

Convenience

1 2 3 4 5 6

Flexibility of appointment times

1 2 3 4 5 6

Suitability of tests used for my child's ability

1 2 3 4 5 6

Confidence in staff testing my child

1 2 3 4 5 6

Verbal communication of test results

1 2 3 4 5 6 ☐ I didn't receive any

Written communication of test results

1 2 3 4 5 6 ☐ I didn't receive any

Other comments

3. **In your opinion, do any of the following benefits or limitations apply to in-school eye tests?** *Please tick any that you think apply.*

Benefits

- ☐ Familiar environment for my child
- ☐ Convenient for parents
- ☐ Parent may not be present
- ☐ Testing can be carried out over multiple short visits if required
- ☐ Other classmates taking part encourages compliance
- ☐ Teacher can ask eye care provider questions directly about child’s vision
- ☐ Increases awareness of vision among teachers
- ☐ Child cooperates better for school stafs

Other ____________________

Limitations

- ☐ Child misses class activities during eye test
- ☐ Parent may not be present
- ☐ Blurred vision from drops disrupts school work
- ☐ Disrupts school routine
- ☐ Unsettling for child
- ☐ Unable to ask eye care provider questions about my child’s eyes at the time of test

Other ____________________

4. **If your child had an eye test in school and needed to get glasses, where would you like to get the glasses from?**
   - ☐ I would be happy for my child to get the glasses at school – I don't mind if I don't choose the glasses
   - ☐ I would be happy for my child to get the glasses at school – as long as I could help choose the glasses
   - ☐ I would prefer to take my child to the local opticians to get glasses
   - ☐ I have no preference

5. **If your child has previously had their eyes tested at <u>the hospital</u> please rate your experience of the following items:** 1= very poor, 2= poor, 3= no strong opinion, 4= good, 5 = very good, 6= don't know

Convenience of attending appointment

1 2 3 4 5 | 6

Flexibility of appointment times

1 2 3 4 5 | 6

Accessibility of clinic (e.g. car parking, location)

1 2 3 4 5 | 6

Waiting time at clinic

1 2 3 4 5 | 6

Suitability of tests used for my child's ability

1 2 3 4 5 6

Surrounding environment/ atmosphere (e.g. noise, space)

1 2 3 4 5 6

Confidence in staff testing my child

1 2 3 4 5 6

Verbal communication of test results

1 2 3 4 5 6 ☐ I didn't receive any

Written communication of test results

1 2 3 4 5 6 ☐ I didn't receive any

Other ____________________

6. **If your child has previously had their eyes tested at <u>the local opticians</u> please rate your experience of the following items:** 1= very poor, 2= poor, 3= no strong opinion, 4= good, 5 = very good, 6=don't know

Convenience of attending appointment

1 2 3 4 5 6

Flexibility of appointment times

1 2 3 4 5 6

Accessibility of practice (e.g. car parking, location)

1 2 3 4 5 6

Waiting time at appointment

1 2 3 4 5 6

Suitability of tests used for my child's ability

1 2 3 4 5 6

Surrounding environment/ atmosphere (e.g. noise, space)

1 2 3 4 5 6

Confidence in staff testing my child

1 2 3 4 5 6

Verbal communication of test results

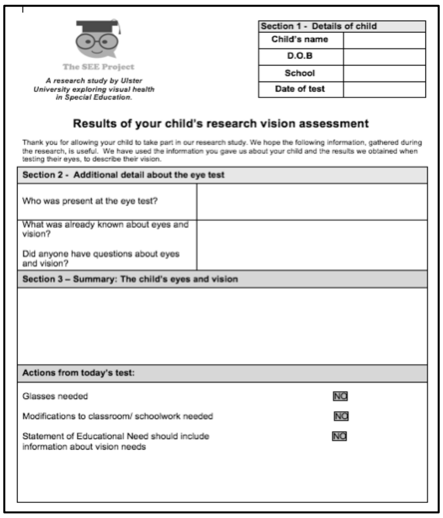
1 2 3 4 5 6 ☐ I didn't receive any

Written communication of test results

1 2 3 4 5 6 ☐ I didn't receive any

Other ____________________

The following questions relate to the report we sent you after we tested your child's eyes in school.


The SEE Project

A research study by Ulster University exploring visual health in Special Education.

Section 1 - Details of child	
Child's name	
D.O.B	
School	
Date of test	

Results of your child's research vision assessment

Thank you for allowing your child to take part in our research study. We hope the following information, gathered during the research, is useful. We have used the information you gave us about your child and the results we obtained when testing their eyes, to describe their vision.

Section 2 - Additional detail about the eye test	
Who was present at the eye test?	
What was already known about eyes and vision? Did anyone have questions about eyes and vision?	

Section 3 – Summary: The child's eyes and vision

Actions from today's test:

Glasses needed	NO
Modifications to classroom/ schoolwork needed	NO
Statement of Educational Need should include information about vision needs	NO

7. **Did you receive a report for your child?**

☐ Yes ☐ No *If no, please go to question 16.*

8. **Did you read the report?** *(Don't worry if you haven't read the report – this is useful for us to know).*

☐ Yes ☐ No

If no, please tell us why you didn't read it, then go to question 16

____

____

9. **Is the information contained in the report useful on a day-to-day basis?**

Not at all useful	Parts are useful	No strong opinion	Quite useful	Very useful
1	2	3	4	5

10. **What were the *most* helpful parts of the report?**

11. **What were the *least* helpful parts of the report?**

12. **Was the information in the report written in a way you could understand?**

Difficult to understand	Somewhat difficult	No strong opinion	Fairly easy	Easy to understand
1	2	3	4	5

13. **Did the report contain any information about your child's eyes and vision that you didn't know about before?**

☐ Yes ☐ No ☐ Not sure

If yes, please provide details.

14. **If the report contained any action points or modifications (e.g. wearing glasses full time, needing large print material etc.) relating to how your child could best use their vision, have any adaptations been made or planned:**

    a) **at home?**

☐ Yes ☐No ☐ Don't know ☐ Not applicable

Please comment on any modifications that have been made, or reasons why modifications have not been made.

---

b) at school?

☐ Yes ☐No ☐ Don't know ☐ Not applicable

15. a) Does your child's Statement of Educational Need (SEN) include information about your child's eyes or vision?

☐ Yes ☐ No ☐ Don't know ☐ Not applicable

b) Do you think it is important to include information about your child's eyes or vision in their SEN?

☐ Yes ☐ No ☐ No strong opinion

16. Please use the space below to make any other comments about The SEE Project. **We would welcome your feedback on the project and value any suggestions about how it can be improved in the future.**

Thank you for taking the time to complete this questionnaire.

Evaluating In-School Vision Testing: How was it for you?

Teacher Questionnaire

We would like to thank you again for taking part in **The SEE Project**. As you know, we have been offering in-school eye examinations to pupils in Castle Tower as part of a research study. We hope that this research will be helpful in planning future eye care services for children in special education.

As part of the research we would like to find out your opinion of the in-school vision testing by completing this short questionnaire. We would be very grateful for your feedback, comments and suggestions. This questionnaire should take 5-10 minutes to complete. **Once completed please return to Alick Ford or Helen Campbell.**

By completing this questionnaire we are assuming that you are giving your consent to participate in this study, however you are free to withdraw at any time. Ethical approval has been granted by the Research Ethics Committee at Ulster University.

Class ________

1. **How useful do you think the in-school eye tests were for the pupils, school staff and parents?**

	Not at all useful	Somewhat useful	No strong opinion	Useful	Very useful
Pupils	1	2	3	4	5
Staff	1	2	3	4	5
Parents	1	2	3	4	5

2. **To what extent do you feel the eye tests disrupted the pupils' other school activities?**

Disrupted a lot		No strong opinion		Did not disrupt at all
1	2	3	4	5

3. **In your opinion, do any of the following benefits or limitations apply to in-school eye tests?** *Please tick any that you think apply*

Benefits

- Familiar environment for child

- Convenient for parents

- Parent may not be present

- Testing can be carried out over multiple short visits if required

- Other classmates taking part encourages compliance

- Teacher can ask eye care provider questions directly about child's vision

- Increases awareness of vision among teachers

Limitations

- Pupils miss class activities during eye test

- Parent may not be present

☐ Not enough staff to accompany pupils

☐ Blurred vision from drops disrupts school work

☐ Disrupts school routine

☐ Unsettling for child

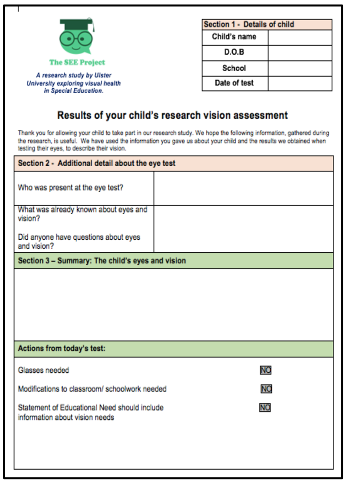
☐ Lack of space available to carry out eye tests

Other

____

____

The following questions relate to the report provided describing your pupils' visual status following their sight test.



The SEE Project

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Section 1 - Details of child	
Child's name	
D.O.B	
School	
Date of test	

Results of your child's research vision assessment

Thank you for allowing your child to take part in our research study. We hope the following information, gathered during the research, is useful. We have used the information you gave us about your child and the results we obtained when testing their eyes, to describe their vision.

Section 2 - Additional detail about the eye test	
Who was present at the eye test?	
What was already known about eyes and vision? Did anyone have questions about eyes and vision?	

Section 3 – Summary: The child's eyes and vision

Actions from today's test:

Glasses needed NO

Modifications to classroom/ schoolwork needed NO

Statement of Educational Need should include information about vision needs NO

4. Did you receive a report for any of your pupils?

☐ Yes ☐ No *If no, go to question 13.*

5. Did you read the report(s)? *(Don't worry if you haven't read the report – this is useful for us to know).*

☐ Yes, straight away. ☐ No, but I plan to during the holidays.

☐ Yes, several weeks later. ☐ No, I have not read the reports.

☐ Yes, several months later. Month read (if known) ____________

If no, please tell us why you didn't read them, then go to question 13

____

____

6. Did you find the information in the report(s) useful and relevant to your work with the pupil(s)?

Not at all useful	No strong opinion	Parts are useful	Quite useful	Very Useful
1	2	3	4	5

7. Was the information contained in the report(s) written in a way you could understand?

Difficult to understand	Somewhat difficult	No strong opinion	Fairly easy	Easy to understand

1 2 3 4 5

8. What were the *<u>most</u>* helpful parts of the report(s)?

10. What were the *<u>least</u>* helpful parts of the report(s)?

11. a) If the report(s) contained any recommendations relating to how the pupil(s) could best use their vision in the classroom, have any adaptations (e.g. classroom position, enlarging text size) been made or planned? *Please provide details.*

Yes ☐ No ☐ Not sure ☐

b) If a child in your class has a vision problem, do you feel confident implementing suggested classroom modifications?

Yes ☐ No ☐ Not sure ☐

c) Would you be interested in having further training to help you adapt a child's learning environment/materials if they had a vision problem?

Yes ☐ No ☐ Not sure ☐

12. Do you think the pupils' Statement of Educational Need should include details from the report(s) if they highlight a visual problem?

Yes ☐ No ☐ No strong opinion ☐

13. Please use the space below to make any other comments about The SEE Project. We would welcome your feedback on the project and value any suggestions about how it can be improved in the future.

Thank you for taking the time to complete this questionnaire

Appendix 7 Additional analysis

Chi-squared tests were performed to determine the presence of significant associations between participant gender/age/learning difficulty/diagnosis and remaining unmet need at follow-up and are summarised in the table below.

		Unmet visual needs resolved at follow-up (n=35)	**Unmet visual needs remaining at follow-up (n=20)**	**Chi squared test**	**p value**
Gender	Female	42.9% (n=15)	25.0% (n=5)	Yate's correction for continuity	p=0.302
	Male	57.1% (n=20)	75.0% (n=15)		
Education level	Primary	74.3% (n=26)	55.0% (n=11)	Yate's correction for continuity	p=0.243
	Post-primary	25.7% (n=9)	45.0% (n=9)		
Learning difficulty	SLD	34.3% (n=12)	65.0% (n=13)	Pearson	p=0.143
	MLD/SLD	20.0% (n=7)	10.0% (n=2)		
	MLD	34.3% (n=12)	20.0% (n=4)		
Autism	Yes	28.6% (n=10)	25.0% (n=5)	Yate's correction for continuity	p=0.920
	No	65.7% (n=23)	75.0% (n=15)		
Down Syndrome	Yes	5.7% (n=2)	35.0% (n=7)	Fisher's exact	**p=0.019**
	No	85.7% (n=30)	65.0% (n=13)		
Cerebral Palsy	Yes	8.6% (n=3)	10.0% (n=2)	Fisher's exact	p=1.000
	No	82.9% (n=29)	90.0% (n=18)		
Epilepsy	Yes	11.4% (n=4)	0%	Fisher's exact	p=0.151
	No	80.0% (n=28)	100% (n=20)		
Hearing impairment	Yes	0%	10.0% (n=2)	Fisher's exact	p=0.143
	No	100% (n=32)	90.0% (n=18)		
Speech and language problems	Yes	71.4% (n=25)	70.0% (n=14)	Yate's correction for continuity	p=0.742
	No	20.0% (n=7)	30.0% (n=6)		